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SYMPOSIUM ON WAR MEDICINE. II.

WAR AND MEDICINE*

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I MUST begin by confessing that I am not an expert in this particular field of medical history. My researches have been along somewhat different lines, although I have touched the history of war surgery in several previous publications.[1] Men like Colonel Fielding H. Garrison[2] and Colonel Edgar E. Hume[3] have made infinitely more important contributions on which I will have to draw heavily. I am, however, extremely interested in the subject because, directly or indirectly, wars have played a very important part in the development of medicine, and also because during the last war I was an army physician myself. Since the subject is very broad, I must limit myself to tracing briefly the development.

War's contribution to medicine is, first of all, negative. It destroys the best results of the physician's work. The elite of a nation, young men trained and nourished scientifically, immunized against a great variety of diseases, are shot to pieces, are killed or crippled. War, however, affects also the health and well-being of the civilian population adversely because it is a catastrophe that usually does not come alone. War, famine, and pestilence have at all times constituted a triad of evils. The farmer has to abandon the plow, the fields are destroyed, the granaries are looted; famine and deficiency diseases result. Transportation is upset. After the Industrial Revolution the population increased in most western European countries beyond the productive capacity of the soil, so that countries had to rely on the importation of foodstuffs. The blockade, therefore, became one of the most formidable weapons, with the result that malnutrition and famines developed. Famine and pesti-

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lence, more than the actual war, devastated Central Europe in the seventeenth century. It was a contributing factor in Napoleon's defeat of 1812. Scurvy played a very important part in the Sixth Crusade in the thirteenth century, but also in the armies of Napoleon in Egypt and Russia, and during the World War in the British army in Kut-el-Amara.

Every war was a fertile breeding ground for the development of epidemics. Large groups of people are massed, filth accumulates, the very subtle public health machinery is frequently upset, the physical resistance of the population is reduced by malnutrition or other factors, epidemics develop, and more than one war has been lost as a result. Greece was saved from Persian invasion in 492 by the outbreak of an epidemic that decimated the Persian armies. The plague of 429, the character of which is still controversial, accelerated the downfall of Athens. An epidemic stopped the Huns before Constantinople in A.D. 425. The Black Death of 1348 had tremendous repercussions on Europe's war history. England, equipped with the new firearms, had defeated the French at Crécy and had conquered Calais after a siege of eleven months. The plague forced them to withdraw and compelled them to sign a truce. The Scottish allies of France, who intended to invade the north of England, were not only defeated by the English troops but also decimated by the plague. The kingdom of Naples was saved by the plague which forced the Hungarian army of occupation to a hurried retreat.

From the Renaissance on, typhus was one of the most dangerous enemies, ever ready to defeat brilliant armies and to play havoc with the civilian population of many countries.[4] The louse was still triumphant in the eighteenth century, and in almost every European war of the period, including the campaigns of Napoleon, more people died from typhus than from wounds. Conditions changed in the second half of the nineteenth century when the battle between soap and the louse resulted in the latter's retreat for the first time. Typhus disappeared from most western European countries, and armies could destroy each other without interference. But the disease remained endemic in eastern Europe, and we all remember the part it played in the First World War, followed by the terrific devastations it caused in Russia from 1918 to 1922. We do not know yet what part typhus will play in the present war. It seems that the disease is still under control, and it is very probable that it will remain so for some time. The actual danger will come later when the war enters its decisive phase, when armies collapse, and civil unrest develops. Then typhus may again raise its head and play its traditional role in the shaping of history.

Until very recently disease caused more casualties than battle wounds. In the Crimean War the French army of 309,000 men lost 20,000 from wounds and 75,000 from disease, a proportion of almost 1 to 4. In the short Italian campaign of 1859, which lasted only two months, the French lost 8,674 men from disease and 3,664 from wounds. In our own Civil War typhoid and dysentery killed more people than the battles. The Franco-Prussian War of 1870 to 1871 was the first to reverse the proportion, at least in the German army. Germany lost 40,881 men, of whom 28,282 were killed by weapons, 346 died from accidents, and 12,253 from disease.

In the past, health standards of the civilian population were affected primarily by the food shortages and epidemics resulting from war. In the total wars of today a new factor has entered the scene. Today wars are fought not only by armies but by nations. Industrial production has become a major weapon and requires the mobilization of a country's entire man power including women. We have no figures yet, but we can readily imagine what health conditions must be among the millions of European workers who have been dragged away from their homes and are performing slave labor for Germany.

In our own country the sudden expansion of the war industries has led to a considerable dislocation of the population. Thousands of workers live in trailers and in shacks, or sleep in "hot beds" which are hardly conducive to health. Already the number of industrial accidents has increased, and we may also expect an increase in the incidence of tuberculosis, which is likely to happen when large numbers of women are drawn into industry. Under normal conditions industrial expansion would call for added medical facilities, but under war conditions the demand cannot be satisfied because the armed forces absorb a high percentage of the available medical personnel and equipment. Thus a vicious circle results which can only be offset by a thorough organization of all medical resources in a way that guarantees maximum efficiency and minimum waste.

There can be no doubt that the major immediate contribution of war to medicine is negative. War is a destructive process which destroys what medicine has endeavored to build. But war, on the other hand, is also a challenge and a stimulus to medicine, both technically and socially. Medicine is always facing a condition of emergency, because in the fight against disease there is no armistice. War, however, is an emergency of a particular kind which puts a nation's medical resources to a severe test. It also provides opportunities for experimentation on a tremendous scale, such as would never be available in times of peace.

Of all branches of medicine, surgery obviously is the one which at all times responded to the war challenge most strongly and in various ways. Armies travel and with them go the army surgeons. They meet colleagues from foreign lands and exchange experiences. This already happened in ancient Greece when Greek surgeons traveled with the mercenaries who were in the army of the Egyptian pharaoh Psammetich. They probably learned from their Egyptian colleagues, which may explain the fact that similar operations are described in the Egyptian and Greek surgical literature. Surgery is not only transmitted through books, but, first of all, in a practical way, with experience being passed on from father to son, from master to pupil. In this process of transmission wars must have played a very important part.

War was also responsible for the erection of hospitals in ancient Rome. The Greeks never had hospitals in our sense; physicians sometimes took a few patients into the guest rooms of their workshop, the *iatreion*, but these were certainly not regular hospitals. In Rome, however, practical considerations led to the establishment of special institutions for the care of certain groups of sick people. Every soldier was a fighting force, and it was in the interest of the army to restore the wounded as quickly and as thoroughly as possible. Lazarettos were, therefore, built, and the foundations of several of them have

been excavated, particularly in the periphery of the Empire. Some of them, like the one in Novaesium, were very elaborate institutions with many sick-rooms opening into large corridors built around a vast courtyard.[5] The military hospital in Baden, in Switzerland, was close to a sulfur spring, and extensive use was made of the medicinal water in the treatment of the wounded.

War, or rather the lack of war, caused the establishment of another kind of Roman hospital, the slave *valetudinaria*. Slaves were cheap as long as wars guaranteed a steady stream of prisoners. But the value of slaves increased considerably once the empire was pacified, and it became profitable to spend money for the restoration of the slaves' health. Thus slave hospitals were erected on the large estates of Roman landowners.

Until the fourteenth century most war wounds were caused by swords, spears, arrows, and similar weapons. They, as a rule, healed by first intention, and in the writings of thirteenth century surgeons wound healing without suppuration was considered the normal process that a physician should strive to attain whenever possible. Conditions changed when firearms were introduced in the fourteenth century. The wounds caused by the large caliber lead bullets of those days were primarily infected, and the view was generally accepted that gunshot wounds were poisoned by gunpowder and had to be treated with the cautery or by pouring boiling oil into the wound. It is well known how a military surgeon, Ambroise Paré, the father of modern surgery, refuted this view on the basis of experiences gained on the battle fields during one of the campaigns of Francis I against Charles V. He proved experimentally that gunshot wounds healed much better without the brutal treatment that destroyed so much of the tissues. But even to Paré suppuration appeared as the normal wound-healing process. Paré's treatise on the treatment of gunshot wounds was published in 1545 and revolutionized war surgery. Thereafter he published a large number of other surgical books, and frequent campaigns in which he participated gave him an opportunity to test his operations on a large scale. He reintroduced the ligature of arteries when performing amputations, was also a pioneer in the field of obstetrical operations, and exerted a tremendous influence in the whole field of surgery.

When John Hunter took part in the expedition to Belle Isle in 1761, the British navy availed itself of the services not only of a surgeon but also of a scientist. On this expedition Hunter gained invaluable experience on gunshot wounds, a subject that he studied all his life and which he finally discussed in his masterpiece, *A Treatise on the Blood, Inflammation and Gunshot Wounds*, that was published in 1794 soon after his death. In those days, most surgeons were still craftsmen who were primarily interested in the practical side of surgery. Hunter was a surgeon also, but a scientist in addition. For him a wound was something more than a practical problem. He was not content to ask, "How can I best heal this wound?" He inquired, "What does the wound signify to the organism? By what mechanisms does the organism safeguard itself against the effects of the wound, immediate and remote?" In this way, almost imperceptibly, he passed from the domain of surgery into that of pathology. The main significance of his work was that he threw open the field of surgical observation and experiment to general medicine. He was the first investigator

since the days of antiquity to advance the theory of inflammation, and there can be no doubt that Hunter's war experience had a great influence on his later researches.

Until the middle of the nineteenth century, the field of surgery was limited to a number of classical operations which had been gradually improved from century to century. Major abdominal surgery was impossible as long as one could not operate on the relaxed body, and also on account of pain and secondary infection. The introduction of general anesthesia in 1846, and of antisepsis in 1867, when Lister's first publications came out, liberated surgery from these age-old bonds. Both methods were immediately applied in war surgery and undoubtedly helped to save thousands of human lives. In 1846 Warren performed his historic operation at the Massachusetts General Hospital, while Morton gave the anesthesia, and the following year Syme applied general anesthesia in the Mexican War and Pirogov did the same in Russia. In 1867 Lister published his first papers, and a few years later the Franco-Prussian War provided an opportunity to apply and test the antiseptic treatment of wounds on a large scale and to gain much experience in the field. The German surgeons, Volkmann, Thiersch, and Mikulicz, were particularly active in developing and popularizing the method.

The Franco-Prussian War also became the testing ground for the efficacy of smallpox vaccination. In the German army, where most soldiers were vaccinated and revaccinated, 4,800 cases of smallpox occurred with 278 deaths, while among the unvaccinated French prisoners alone 14,000 cases occurred with 2,000 deaths.

All fields of medicine felt the challenge of war, surgery more than any other, but also public health was stimulated. Problems of sanitation were particularly acute in times of war, and in the seventeenth and eighteenth centuries many books were written on the sanitation of camps and barracks and on general problems of military hygiene. In 1738 a great soldier, the Maréchal de Saxe, wrote a book with the title, *Rêveries ou mémoires sur l'art de la guerre.* It was the result of thirteen nights of insomnia when he was suffering from a fever disease, not a textbook on strategy, but a thoughtful book on military hygiene. Uniforms were more spectacular than convenient. They were devised to satisfy the vanity of the ruler and to make the soldiers attractive to the fair sex as a compensation for the professional risks they ran. The Maréchal de Saxe advocated a different type of uniform better adapted to the purpose they had to serve. He also gave much thought to the soldiers' diet. Long before Liebig, in the middle of the eighteenth century, meat extracts were prepared to feed soldiers during campaigns.[6]

War had repercussions not only on medical science but also on the humanitarian side of medicine. Florence Nightingale would have become the reformer of nursing without a Crimean War, but there can be no doubt that the experience she gained at Scutari in those terrible years 1854 to 1856 accelerated developments tremendously. October 21, 1854, the day when she left England with 38 nurses, truly marks a turning point in the history of nursing. Placed all of a sudden under conditions of great emergency, Florence

Nightingale saw and did more in less than two years than she could have done in a lifetime in England. The Crimean War thus actually became the cradle of modern nursing, just as the Battle of Solferino in 1859 became the starting point of the Red Cross. The Geneva banker, Henri Dunant, who was visiting Italy as a tourist, suddenly found himself on the battlefield of Solferino and was so stirred by what he saw that he devoted his entire life to the alleviation of the sufferings of the wounded and prisoners of war. In October, 1863, 62 delegates, representing 16 nations, convened at Geneva, and the Red Cross Society was founded the following year. As we all know, it has extended its scope far beyond war activities and in every country is playing a tremendous part in relieving human suffering.

Ambroise Paré and John Hunter, whom we mentioned before, served as army surgeons, but only occasionally. Paré was surgeon-in-ordinary to several French kings, and it was obvious that he accompanied them whenever they went to war, but otherwise he practiced surgery as a civilian in Paris. John Hunter's military period was only an episode in his life, although an important one. Great contributions have been made to medical science, however, by medical men for whom the army was a career, and there can be no doubt that no medical corps in the world has done more for the advancement of science than that of the United States Army. It is impossible to list all these contributions, and all I can do is to recall a few names: Beaumont who experimented in the wilderness on the gastric juice; John Billings whose contribution to hospital construction, medical education, vital statistics, and the development of libraries has been unsurpassed; the heroic work on yellow fever of Sternberg, Reed, Carroll, Lazear, Agramonte; Gorgas whose activities extended far beyond the Panama Canal and who was instrumental in organizing medical services in the gold mines of South Africa; Ashford's studies on hookworm, Craig's on malaria, Woodward's on photomicrography. Colonel Hume has recently shown in a scholarly publication what great contributions army surgeons made to the science of ornithology.[7] There is hardly a field of general or medical science that has not been enriched by members of the United States Army Medical Corps, and the Army Medical Library in Washington with its splendid collections and bibliographies is a unique institution that has played an important part in the development of American medicine.

There is one thing we can learn from history, namely, how tremendously important the medical corps is. There was a time, not so long ago, when the generals used to consider the medical officer a nuisance, the man who always interfered with their dispositions. They forgot how many campaigns were lost in spite of brilliant strategy as a result of diseases. Views are changing rapidly, and the war departments are recognizing the need for mobilizing all the resources of medical science.

Medicine learned from every war, and the more science progressed the more medicine became able to save human lives even in war. The soldiers who today are sent to foreign lands are immunized against many once fatal diseases; they are nourished scientifically and they carry along the vitamins needed to protect them from deficiency diseases. They are clothed infinitely

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more hygienically than in the past. Operative results have been greatly improved, and the new methods of blood transfusion are saving countless lives. The great progress achieved by orthopedics makes it possible to rehabilitate the wounded infinitely better than in the past. In previous centuries little attention was paid to crippled war veterans. A few were assigned to the care of monasteries, but the great majority became beggars roaming the streets. It was Louis XIV in France who established the *Hôtel des Invalides* in Paris, an institution in which invalid veterans were attended at the expense of the state.

The rehabilitation of the crippled veterans is one of the most important social problems of war medicine today. Pensions alone do not solve the problem. Work is one of the major balancing factors of health, and there is plenty of skilled labor that can be performed by blind and maimed veterans. Every effort must be made to readjust the invalid to his environment so that he can continue to live as a useful member of society and thus preserve his self-respect. The Soviet Union is handling the problem in an admirable way. Special schools have been established for the purpose, giving general and vocational training in courses that may last as long as two years. Invalids who had only elementary education may improve their general knowledge by taking courses of secondary education. Vocational training produces bookkeepers, technicians, agricultural experts, tailors, photographers, telegraph operators, etc. The Commissariats of Social Welfare are in charge of rehabilitation programs. Local social welfare bodies must place invalids within two days, and all industrial and other enterprises are urged to provide suitable work and housing for the veterans, who are visited by special commissions every month.

War is not a natural catastrophe or a biological process, as has sometimes been said. It is man made and represents a primitive method of conducting international politics. Civilization is a very young phenomenon in the history of mankind, so that we should not be astonished that relapses into primitive savagery still occur. There is no reason, however, why we should not be able to develop in the course of time from a competitive to a cooperative society on a world-wide scale. As long as wars occurred they always had definite results that affected social and economic conditions of the countries involved in a way that was either detrimental or beneficial to the development of medicine.[8]

The campaigns of Alexander the Great propagated Greek culture all over the ancient world and created conditions favorable to the development of medicine in such countries as Egypt and Syria. The Roman conquest of western Europe pacified the Germanic tribes, developed trade, and permitted cultural developments that also benefited medicine. Persian medicine flourished as never before after the Arabic conquest, and Persia became an important province of Islamic civilization.

The Thirty Years' War, on the other hand, was a strongly retarding factor, not only on account of the destruction it brought all over central Europe, but also because it perpetuated feudalistic trends. The emergency created by the revolutionary wars of France greatly accelerated the reorganization of medicine initiated by the revolutionary government. The reforms were continued by Napoleon and became the foundation upon which the French school developed and flourished. The Franco-Prussian War liberated France from

the rottenness of the Second Empire, and led to the establishment of the Third Republic under which science and medicine reached great heights. The World War of 1914-1918 stimulated medical science in many ways as we all remember. Yet the contribution of that war to medicine was probably still greater in the field of social medicine. The war had demonstrated the importance of protecting the workers' health, and industrial medicine developed as never before. Workmen's compensation was introduced in a number of countries, and general health insurance in France. Various countries established ministries of health, and the Soviet Union made a totally new departure in creating the type of medical organization best adapted to the new industrial society and the new technology of medicine.

In the United States the examination of almost three million drafted men revealed that 47 per cent were defective; in other words, that health conditions were not as good as they could have been and that there was a maladjustment in the distribution of medical care. The Committee on the Costs of Medical Care was founded. Other agencies joined in the work, and for ten years surveys were made that provided us with the facts and figures needed for intelligent planning.

The war in which we are engaged at present will undoubtedly again stimulate medical science, but I am convinced that its social effects will be much more strongly felt. It would be foolish to assume, as some people do, that Europe is finished. Europe is going through one of its periodic crises, and the very destruction will force the European nations to reorganize their social and economic structure from the bottom. Thus conditions may well be created that will enable medicine to develop more rapidly and more broadly than in the past.

The war is demonstrating to us that our technology has outrun our sociology. We have created ingenious machines, but not the social and economic organization that an industrial society requires. We have built means of transportation that overbridge the continents, but not the apparatus that insures peaceful cooperation between nations. The same happened in medicine, and now, under pressure of the emergency, we have to organize medical services, not only for the armed forces but for the nation. If we learn a lesson from this experience, it may well become this war's greatest contribution to medicine.

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BACTERIAL WARFARE

The Use of Biologic Agents in Warfare

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Editor's Note.—This article was first published by Colonel Fox, then Major Fox, in March, 1933. It has been republished and quoted extensively in technical military periodicals. It was republished in The Military Surgeon in May, 1942. The author states that, while some advances have been made since the original publication of this article, the principles are as applicable today as when first stated.

BACTERIAL warfare is one of the recent scare-heads that we are being served by the pseudoscientists who contribute to the flaming pages of the Sunday annexes syndicated over the Nation's press. This question of bacterial warfare has been brought forward from time to time since the World War. The use of the organisms that cause communicable diseases as an instrument of warfare was considered by the Conference on the Limitation of Armaments held in Washington in 1922. An international commission consisting of Professors Pfeiffer (Breslau), Bordet (Pasteur Institute), Madsen (Copenhagen), and Cannon (Harvard), appointed at the time, reported to the League of Nations essentially as follows: (a) The effects of bacterial injury cannot be limited or localized. (b) Modern water purification methods protect against the organisms of typhoid and cholera. (c) Plague is a disease that would be as dangerous for the force using the organisms as for the attacked. (d) The danger from typhus has been exaggerated. (e) Modern sanitary methods are effective in controlling communicable diseases.

Following this pronouncement by these eminent scientists, the question of bacterial warfare suffered a lapse of interest; but during the past year, as an incident of the preparation for the Geneva Convention, there has been a marked revival of interest in this supposed bugbear, bacterial warfare. Possibly this is only a part of the effort of professional pacifists to add all the imaginary frightfulness they can picture to the known real horrors of war.

The space and thought that have been given to this question by feature writers have not been without effect, and many people now believe that bacterial warfare represents a real threat and problem for future generations. Many are now associating chemical warfare and bacterial warfare, with the result that in the resolution of adjournment, voted by the General Commission of the Disarmament Conference on July 23, 1932, at Geneva, we find chemical, bacteriological, and incendiary warfare grouped for consideration. The mere fact that this great body of peace workers considers bacterial warfare seriously enough to prohibit its use justifies military men in considering this agency of

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warfare. We know how little treaties protect; so we should study the question to see if the use of biologic weapons is a real problem for the military minds of the future.

Under biologics we include all those organisms that may invade the body of man or animal to produce disease, so that while we use the term bacterial warfare, we do not limit this paper to a consideration of bacterial diseases. We will also consider the filtrable viruses, Protozoa, and other pathogenic forms as well as their toxic products.

With the powers of the world in session at Geneva discussing the future of warfare, and with some of the great nations of the world recommending the complete abolition of chemical warfare, it may appear strange to have one consider biologic warfare. I believe all will agree that while it is a mistake to live in the past, it is equally undesirable to ignore the lessons of the past in prognosticating regarding the future. It is therefore well, before we consider the possible use of biologics in warfare, to discuss briefly the question, Will the nations of the world abandon the use of chemicals as an instrument of warfare?

Every advance in thought or design meets reaction and antagonism from the minds of the previous generation. It does not take some radical departure from the accepted views of the day, such as marked the revolutionary concept of Copernicus or Darwin, to start all "as is" conservatives on a tirade of opposition with the usual tenor of their remarks: "It is against the law of nature," "It is against religion," "It conflicts with all known law," "Even if true, it does not fit into the existing order of things." A man of middle age today may remember the old mossback who refused to ride on the train of the nineteenth century. In fact, the train and street car had not completely overcome all the pooh-poohs of the backward ignoramus until they were involved in a fight for their very existence with a newer means of transportation—the motor. The motor vehicle had just had time to have a proper road net constructed when this engine, becoming "air-minded," needs no roads. Have they been generally accepted? Certainly. However, remarks such as, "If God wished man to fly he would have given him wings," were made in the pulpits of this country during the present century.

It takes more than the harpings of the minds of yesterday to scotch the wheels of progress. It may startle many to talk of world progress in connection with implements of warfare. However, it is not believed that any fair-minded individual can deny the place in world advancement that is due to the spirit of conquest. The peaceful shepherd, content to watch his flocks, has added little to the world's knowledge. The trader and warrior have discovered and spread knowledge. Trader and warrior are almost inseparably associated throughout history, and slowly as they may have progressed, they usually lead the thought of the day. The spirit of adventure and discovery has always marched with the warrior. The discoveries of the warrior are not limited to implements of war; however, these are the factors we wish to consider. In this field again we meet the same antagonism at every advance that the fighting man has made, an antagonism that has affected all minds of the "as is" type, including conservative and reactionary individuals. Every advance, every discov-

ery of a new weapon by the fighting man, has had to overcome two groups of opponents: (1) The fixed and established military group that is always sure the new weapon "won't work," "Is not as good as older weapons," "Not practical," etc., (2) The pacifist group—the shepherd group, that considers each new weapon more terrible than the former and cries out against it.

Primitive man in his combats certainly had no weapons. Are there any today who believe that this early creature did not fight over "food and females?" It may be added that all combat ultimately resolves itself in the final analysis to a strife for one of these basic biologic requirements—nourishment or sex. Fighting over gods was a later development; and these fights over gods were over a personal God, a God of the land or tribe, a God to favor their own special country, a benevolent God who would make their country a more bountiful place to live.

In the early combats man could only bite and claw and choke an adversary. This was the day of brute strength. Cleverness had relatively little value. The first man to use a weapon was the man with the best mind of his day. The first weapon used must have been very simple and elementary. Possibly a hard object held in the hand with which he brained his opponent. This weapon possibly did not create much comment. This was not an age of comment; however, the descendants of the type that could not learn to use this weapon are not numerous. Has this weapon been abandoned? Certainly not. It is an excellent weapon, and no good weapon has ever been discarded. Its use today is very limited because of the discovery of other weapons of greater range and effectiveness.

Development of weapons has always been for the purpose of using intelligence to overcome mere physical force. The factor of range, killing an opponent before he can close with you, is a most important factor when the man of intelligence must meet superior physical force or number. Probably the first weapon to provide range was a club, possibly a sharp stick, the forerunner of the iron-tipped spear. The club may have had a stone head attached. These weapons not only advanced the clever man over the mere strong man; they aided man in his fight with the man-eating animals of the time. However, if we can make deductions from the early cave records of men of this period, advance was slow because the intelligence was of such low order that they were slow to understand and accept these new weapons. The race improved because the thinker, the successful warrior, lived and won the females and left descendants; the slow and reactionary type did not live to reproduce. With every advance in weapons man is giving evidence of a desire to overcome brute strength by means of a weapon with range and effectiveness.

We can picture the introduction of the early propelled instruments, such as the arrow, causing a storm of opposition. Some youngster designed some form of propelling instrument for a sharp stick and possibly suffered the jeers of the snaggled tooth elders as he shot the sticks into inanimate targets, and received only the reward of complete recognition when he shot a sharp stick through the belly of an old pack leader to take over a band of cowed females. The progeny of this genius were of a higher order of mentality and possibly soon learned the

value of organization, with the result that a tribe of arrow users developed. This seemed like the final advance, and who can doubt their ability to inflict their will on the men of the time.

The fact that the conquered men, possibly of superior physical development, considered the weapon a cruel and brutal implement that God had not endowed man with did not cause it to fall into disuse. The only thing that caused this weapon to fall into disuse, and finally be practically abandoned, was the development of such protection as caused the implement to cease to be effective or because other instruments were designed of greater range and effectiveness. These factors are the only things that have ever caused a weapon used successfully to be abandoned.

The outcry against the use of chemicals seems to people of this day to be quite a serious factor, and some wonder if their use will be curtailed by this influence. The following factors should be considered before we make a decision: (a) No effective weapon once introduced has ever been abandoned until it was displaced by a more effective weapon or protection was developed that rendered the instrument useless. (b) The hue and cry that attended the introduction of chemicals are not unusual on the introduction of a new weapon. The early use of gunpowder produced a reaction in every respect similar to the cry of the present day pacifist against gas. Will the use of chemicals in warfare be abandoned? Probably not. Will the use of chemicals be curtailed? Certainly; just as certain as the race progresses, just as certain as new and more effective weapons are designed—not before this advance is made.

Will the next advance in warfare see the use of biologics? Will the next agent used be the living organisms, bacterial warfare, the scourge of armies from the most ancient times—the communicable diseases? The question of biologic warfare will be considered in more detail because here again we run into the most elaborate and fanciful statements.

A review of military history will reveal the great influence that disease has played in past wars. Results have been decisively influenced in many campaigns by epidemics of communicable disease. In some campaigns they have caused such tremendous losses and such great numbers of noneffectives that the combat has reached a stalemate. However, in certain instances, for unknown reasons, there has been a great difference in the degree to which combatants have reacted to the epidemic conditions. In a few cases we are able to understand why the communicable diseases appeared to have greater invasive power toward one of the armies; in other instances we do not understand clearly why there was a difference in the degree of involvement of the forces.

Volumes have been written on the epidemic diseases that have attacked the military forces. We will not attempt to review this extensive literature, but the doctor, especially the epidemiologist, knows that the student of history who reads only of tactics and strategy, the victories and defeats of a campaign, without familiarity with the medical history of the war, is likely to give some commander credit for success or failure that all too often has been caused by some epidemic of communicable disease. This is not meant to depreciate military success, for

the great general is often a great sanitarian, and even Alexander may owe a part of his success to his doctor, philosopher, teacher—Aristotle's advice to "boil his water and bury his dung."

We must remember that we can march through the pages of military history all the way to the twentieth century before we come to a campaign where the missiles of the enemy produce more casualties than epidemic disease. In most of the ancient campaigns of any duration some one of the great military plagues did more to decimate the military forces than all the man-made munitions. I say one advisedly, although often many infections raged and famine and scurvy accompanied the communicable diseases.

What was the nature of these ancient pests? Were they diseases of that age now no longer known? No, the military pests that existed then are still with us. The Big Six of all time (wartimes) are: (1) the enteric fevers, typhoid and the paratyphoids; (2) the dysenteries; (3) cholera; (4) typhus; (5) the plague, bubonic plague, the Black Death; (6) smallpox.

Do not consider for a moment that the above diseases had any monopoly on the right to destroy armies. It is probable that at times influenza and the epidemic pneumonias took such heavy toll that only little fuel was left to be consumed by the Big Six. Again, under conditions where malaria is endemic, this disease is second to none in the production of noneffectives in military ranks. In fact, measles and epidemic meningitis may well be added to the list of military scourges.

This paper is not for the purpose of considering the epidemic conditions of the armies of the past, but it is realized that many individuals will naturally consider that if these infectious agents were able to produce such frightful outbreaks of disease by the simple process of chance infection under natural conditions, then in the hands of man, as a military weapon, they may well prove even more destructive. They may fail to consider the fact that the same measures that are now so efficacious against the chance infections occurring in nature may prove of equal value in combating the same agency of destruction when used by man.

We have presented biologic warfare in all its horrors; now let us analyze the problem in detail. What agents can be used to produce death and disease? How can these agents be introduced into the bodies of the enemy? We will discuss these questions in the order stated. The biologic agents available for warfare are: (1) the communicable diseases; (2) other infective processes (such as wound infections); (3) toxic products of bacteria.

The communicable diseases are well known. They are the so-called transmissible diseases that produce epidemics. They are caused by a living contagion and are spread from man to man or animal to man by various channels of transmission. All of the Big Six and the other diseases mentioned above belong to this group.

The second group, the other infective processes that are available, include such infective materials as the agents that infect wounds: gas gangrene, tetanus, anthrax, and other wound contaminations that are infectious but not communicable.

The last group of dangerous agents are the toxic products of bacterial growth. We will mention but a single terror-inspiring example—botulinus toxin.

A portion of this toxin almost inconceivably small when introduced into the body by any channel is lethal. We will give details later.

No one will question the effectiveness of all these agents in producing casualties when introduced into the bodies of unprotected and nonimmunized individuals. The important question then is how? How are these agents to be introduced into the bodies of the enemy to produce casualties?

Any consideration of the deliberate use of pathogenic organisms as a means of warfare will have to consider the question of how to produce a destructive epidemic in the forces of an opponent and at the same time protect one's own forces from invasion by the virulent organisms in question. Certainly at the present time we know of no disease-producing microorganisms that will respect uniform or insignia, and the use of bacteria in warfare for the destruction of opposing forces will have to be predicated upon the successful prior immunization or the complete isolation of the forces employing the disease-producing organisms through some system of quarantine.

Any intelligent discussion of bacterial warfare must certainly give detailed consideration to the question of how the living contagion is to be introduced into the individuals that are to be infected. We can well begin this investigation by a study of the channels of infection. The communicable diseases may be classified on the basis of their "routes of transmission." By this is meant the path that the living contagion follows when it leaves the body of the sick man or animal, or in some cases the carrier, to enter the body of the susceptible host to produce disease. On this basis we may classify the communicable diseases into intestinal diseases, respiratory diseases, direct contact diseases, and insect-transmitted diseases.

The intestinal diseases are produced when some small portion, usually a microscopic portion, of the material from the intestinal canal of the sick man with its living microorganisms, is introduced into the alimentary canal of the susceptible individual. Typhoid, cholera, and dysentery are well-known examples of this type of disease.

The respiratory diseases, sometimes known as "sputa-borne" or even "air-borne" diseases, are the communicable diseases spread by the transmission of living microorganisms from the respiratory tract of the sick to the respiratory tract of the invaded. This group of diseases is of tremendous importance and embraces such conditions as the common cold, influenza, pneumonia, diphtheria, epidemic meningitis, smallpox, and possibly of special importance for war purposes, the pneumonic form of bubonic plague.

The group of diseases that we refer to as "insect-transmitted" are those where the invasion of the new host is effected by the bites of insects which have previously fed on an individual—man or animal—infected with the disease in question. A period of incubation on the part of the insect between feedings on sick and feedings on individuals to be infected is necessary in certain instances; with other diseases such interval is not required. Examples of insect-transmitted diseases that require an interval for the development of the contagion within the body of the insect after feeding on the infected individual are malaria and yellow

fever, both transmitted by mosquitoes. Bubonic plague, a disease of rats that is transmitted to man by the bite of the rat flea, does not require an incubationary period for the rat flea to develop infectiveness.

The venereal diseases are direct contact diseases. They are of profound military importance and have proved decisive factors in certain past wars, notably influencing the European campaigns of the fifteenth and sixteenth centuries. The deliberate use, however, of this means of injury is fraught with difficulties when we plan a method of securing personnel to effect the necessary exposure. The soldier's danger from the venereal diseases will not come from the open, avowed wartime enemy who loves him least, but from the money-loving or uniform-worshipping ladies who profess to love him most. Therefore, while these diseases may at times exceed all other causes of military noneffectiveness, we can dismiss them without further discussion while we are considering bacterial warfare.

It follows, then, that the communicable diseases that constitute an epidemic or pandemic threat to the military forces are the intestinal, respiratory, and insect-transmitted diseases.

THE INTESTINAL DISEASES

Mankind is all too familiar with the terrible epidemics of typhoid, cholera, dysentery, and the diarrheal conditions that have destroyed military forces in the past. However, it is highly questionable if this group of diseases will ever in the future cause any such terrible catastrophes, for the reason that the epidemiology of these infections is so thoroughly understood that modern sanitary methods and immunization processes have rendered comparatively innocuous these hazards of earlier armies.

The deliberate use in warfare of these agents, however, we shall consider. While occasional small outbreaks of these diseases may be due to food infections, real epidemics of this group of diseases are traceable only to infected water and milk supplies, or to such a complete sanitary breakdown that general fecal contamination of food supplies occurs. The possibility of contaminating a milk supply presents practically insurmountable difficulties, although it is theoretically possible that spies might use such a means to discommode and harass civil populations. Of course, it has no practical application to the military forces themselves.

Contamination of water supplies of civilian communities by means of infection of large reservoirs and storage basins where the water is held awaiting consumption is a possibility. Contamination, to be effective, would have to be subsequent to treatment by the modern water purification plant consisting of filtration and chlorination, or, of course, it would be valueless; but this is within the range of possibilities, and it is possible that future wars will reveal that spies will make an effort to contaminate municipal water supplies.

The use of the intestinal group of diseases against forces in the field would probable prove entirely ineffective because modern water purification methods and the close supervision of the water supply that is accepted as a necessary incident of military service will absolutely preclude the successful employment of this means of combat.

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In considering the intestinal group it may be well to stress the fact that the reason modern armies, and for that matter all civilized communities, do not have serious epidemics of these diseases is not that the infective agents that cause these diseases are not present or available, but that modern sanitation protects the personnel.

Let us take a typical example, typhoid fever. The incidence of typhoid in our civil population has been greatly reduced during the present century. Let no one think, however, that this is due to any scarcity of the typhoid bacillus, and it must also be remembered that the civil population has not had any general immunization such as helps to protect the Army. Typhoid has not retreated to the outskirts of civilization; it is all about us. Every state, yes, every county in the Union, is infected. Typhoid carriers in the United States possibly number 100,000 and are generally without supervision. The reason we have only about 5,000 deaths from typhoid fever per year in the United States of America instead of about 100,000 deaths is that the great mass of our people now use water that has been rendered safe by filtration and chlorination. They consume milk that has been pasteurized and other foods that have been protected.

The same statement may be made concerning the low incidence of the dysenteries in our country. The infection is present, but epidemics do not occur because our sanitary measures are effective. We need not fear infection from without with this group of diseases; we are already grossly contaminated.

The die-hards will say that cholera is not so easily handled and is not at present a problem in America. Granted. We do not have cholera in the States; but our Army and our people do live in the presence of cholera without having epidemics of the disease. The Philippine Islands, where our Army maintains an effective fighting force entirely free from this terrible scourge, has a carrier incidence of the vibrio that causes cholera that is always high. The intestinal group of diseases will certainly not prove destructive against any civilized nation that cares to pay the price of the protection that modern sanitary methods provide.

THE RESPIRATORY DISEASES

In leaving the intestinal group of diseases we proceed from the problem that represents the greatest triumph in preventive medicine to the group of diseases that baffles the best efforts of all health workers. In the control of the intestinal diseases we have so much to be proud of. In preventing the respiratory diseases we have accomplished so little. This is stated with a full knowledge of the wonderful results that have been obtained with smallpox vaccination, and the immunization to diphtheria by the use of toxin products, as well as with a full realization of the fact that we are on the threshold of equally great accomplishments in controlling scarlet fever.

It should be noted that these great accomplishments are not sanitary triumphs, such as glorify our work with the intestinal group of diseases, but immunization processes. Not being able to prevent the infection reaching mankind, we take advantage of the fact that familiarity with the organism, while not breeding contempt, does produce immunity. Therefore, we use the only method that appears to offer any great protection against the respiratory dis-

eases in nature, namely, immunization. It must be admitted that health workers can accomplish practically nothing in the way of protecting peoples from infection with the great host of respiratory invaders, and such protection as we have is due to either natural or artificial exposure to these organisms.

In this group of diseases we find a number of maladies that are serious enough to be effective war weapons if ways of using them can be devised. However, before proceeding we should call attention to the fact that in this group are also a large number of diseases that are not suited for military purposes. For instance, smallpox, while a very serious epidemic disease, must be dismissed immediately. All military forces are immunized to this dreadful scourge, and we can, therefore, dismiss it from further consideration.

Many of the diseases of childhood, while constituting a military problem at time of mobilizing rural recruits, are not suitable for military purposes for the reason that the factor of age susceptibility plays so much importance when we consider the entire group that comprises our population. As an example we may mention diphtheria. While in childhood a very high percentage of the population is susceptible to this disease, the great majority of these same individuals develop considerable natural immunity to the organism that causes diphtheria without further interference than the normal aging. Therefore, while we see epidemics of diphtheria in schools and orphanages, we do not encounter serious outbreaks involving large numbers of any adult population. This disease is cited only as an example wherein the factor of age susceptibility is important; there are a number of diseases that show this phenomenon and would, therefore, be unsuited as offensive military weapons.

Certain conditions such as influenza, pneumonia, and the common cold do not show a marked tendency to limit their injury to any one age group and would be efficacious if they could be used against military personnel. Mankind is as helpless today as at any period in history in the control of these diseases; also they are very serious conditions that produce great numbers of noneffectives, and in the instance of the epidemic pneumonia they result in a tremendous mortality.

Before we surrender to the individuals who threaten such frightful havoc with this group, we may well ask how are they going to start an epidemic of influenza, pneumonia, or the common cold. If they answer that they will introduce the germs that cause these diseases, we can well laugh at them. The process is not so simple. The factors that make respiratory epidemics are not so elementary. They include not only the infection of the individual, but the question of the resistance of the infected animal. The organisms that cause these diseases are all about us. They are always with us. Epidemics mean more than simply infection; they mean the rapid transfer from individual to individual of these infective agents. They mean a lapse in the immunity of the invaded, and possibly something else.

I do not know of a bacteriologist or an epidemiologist who can tell you how to start a respiratory epidemic unless the stage is especially set. I know many who are certain that whenever you place a large group of individuals, man or beast, under poor hygienic conditions, with overcrowding, poor ventilation,

and exposure to unfavorable climatic conditions, or other factors that decrease resistance, respiratory outbreaks will occur in spite of any precautions that can be taken, and that if large numbers of highly susceptible individuals (rural populations) are present, the outbreak can be expected to assume epidemic proportions.

It is also worthy of note that when epidemic conditions prevail, certain organisms may possibly have greater invasive power, for then apparently populations that were not so susceptible or readily invaded may be attacked when they previously escaped injury. It will be noted that as in the case of the intestinal diseases, so with the respiratory diseases it is not a simple case of introducing infection that constitutes a menace. The organisms that produce most of these diseases are always with us, and epidemics mean more than infection. While we cannot understand exactly how epidemics start, and we question the ability of a military agency deliberately to produce an epidemic of one of these diseases, we feel certain that if bacterial warfare is ever contemplated, they will not think of using the respiratory group of invaders for the reason that quarantine, isolation, and all other methods to control diseases such as influenza, are practically valueless. The torch once set off might destroy friend and foe alike, and would, therefore, prove of no value as a military weapon.

The two diseases in this group that are most frequently mentioned are influenza and epidemic meningitis (cerebrospinal fever), possibly because of their importance during the World War. All that has been stated above applies with especial force to influenza, where in addition to the fact that no one knows how to control this disease, we must add that we are not even positive about the actual organism that causes the condition. Epidemic meningitis, on the other hand, is a very definite, specific disease due to a very well-known organism. We must admit at the outset that this is a very serious disease, and that it often assumes epidemic proportions in military organizations. However, if we stop to consider the nature of the organism and the epidemiology, we see how entirely unsuited epidemic meningitis is for use as a military weapon. The organism, the micrococcus of Weichselbaum, is so delicate that even on the most favorable culture media it rapidly dies when exposed for even a few hours to temperatures much below that of blood heat. This disease is spread by carriers, and the organism must be introduced almost directly from the nasal pharynx of the carrier to the respiratory mucous membrane of the individual invaded or it will be destroyed by the unfavorable temperature conditions while en route.

Those individuals who think this disease may be used for military purposes will answer that carriers in the forms of prisoners, etc., would be introduced into the opposing forces. To those who know anything about epidemic meningitis this suggestion is ridiculous. Any military aggregation of any great size already has so many carriers present (anywhere from 2 to 30 per cent) that the introduction of a few more or less is of no moment. Epidemics of meningitis occur only when *overcrowding* is associated with conditions that lower the general resistance, as exposure, unfavorable climatic conditions, and fatigue. Meningitis is, and probably always will be, a military problem; but the individual's friends and associates, not the enemy, are the great problem with this disease.

We will not take up in detail all of the various respiratory diseases. The tabulation would prove tiresome, for the story would always be not so much a question of the great danger of the introduction of the infective agent, but the creation of epidemic conditions, a soil in which the organism could produce an epidemic, overcrowding, and lessened resistance.

THE INSECT-TRANSMITTED DISEASES

These diseases will probably most certainly influence wars of the future as they have in the past. An invasion of such a country as Mexico, at the present time, could constitute more of a sanitary than a military problem. With malaria, dengue, and possibly even yellow fever along the seaboards, and typhus endemic in the plateau district, our main problems would be sanitary. Bubonic plague might also be encountered here as well as in any other place. This disease, bubonic plague, is the disease entity that many consider best suited for military purposes. To begin with, it is a frightfully serious malady, a decimating disease that has most profoundly influenced warfare in the past. It is possible that the rise of the Mohammedan world was due to a great extent to the fact that Europe was in the throes of the greatest scourge mankind has known, the plague, at the time that Mohammed's followers were ready to organize and extend the influence of the crescent until the horns were about to encircle the Mediterranean. Certainly these Arabian tribesmen had never shown any signs of military greatness or valor prior to this period, and it is probable that their religious ardor would have met with small success against the well-organized nations of the time if these nations had not been practically exsanguinated by the "Black Death."

The use of bubonic plague today against a field force, when the forces are actually in contact, is unthinkable for the simple reason that the epidemic could not be controlled. Infected personnel captured would provide the spark to set off possible outbreaks of pneumonic plague in the ranks of the captors. Infected rats would also visit and spread the condition. An advance over terrain infected with plague-bearing rats would be dangerous. Therefore, except as a last desperate, despairing hope of a rapidly retreating army, the use of plague by forces in the field is not to be considered.

The use of plague to harass civil populations presents less difficulty than the use of the organisms against a field force. Those who think that plague will be used as an offensive weapon consider that civil communities may be infected by introducing plague-infected rats. Of course, this is easier to state than to accomplish, but it may be possible for airplanes flying low to drop recently infected rats. At least this is the statement that the individuals make who consider the use of this weapon feasible. Even with so terrible a pandemic disease as plague, however, there is a great deal more to the question of epidemics than mere infection. For instance, to cite an example, one that Gill so forcibly states, "Not half a dozen cases of plague occurred amongst Europeans (including British troops) stationed in the Punjab during the year 1924, when about 500,000, or one-fortieth of the indigenous population suffered from the disease."[1] If these intelligent people were able to avoid the infection when residing in an environment that was literally infiltrated with the infection, it certainly should be possible to control bubonic plague in a population such as we have.

For that matter, the question of plague is not a condition that takes us to the outskirts of civilization. Our own Pacific Seaboard became infected in 1900, and following the San Francisco earthquake the infection extended and is now more or less endemic as a rodent disease, involving not only rats but also ground squirrels. Here again it is not a question of can we control the infection; we are controlling it, and we have not had an outbreak of human plague of sufficient size to designate as an epidemic.

The other insect-transmitted disease that is most frequently assigned a place of importance as an agent suited for warfare is typhus. This disease is certainly terrible enough to satisfy even those individuals who are anxious to preach the gospel of frightfulness. The military and civil populations that have been destroyed by typhus bear witness to how effective this agent of destruction can be. However, again we have a condition that is easily controlled. Complete solution of the problem of endemic typhus is not yet in print, although it is probable that the work of such men as Dyer, Maxey, and Zinsser will soon offer a complete explanation of how this scourge simmers along during the interepidemic periods. Epidemic typhus is thoroughly understood. The epidemiology is so simple that it can be embraced in the name of the transmitting insect, the body louse. The control of epidemic typhus is the simple question of the control of louse infestations. Of course, quarantine will help to prevent the introduction of the infection, but quarantine is futile if the Army is allowed to become lousy. The lousy Army may become the victim of typhus, even in America, without the introduction of infection from extraneous sources. The weight of opinion in the minds of best epidemiologists is that, as Maxey suggested, endemic typhus is probably carried over between epidemics in a rodent reservoir. Endemic cases occasionally occur when transmitted to man by an insect, and when the infection is passed from man to man by the body louse, with the resulting enhancement of virulence, epidemics may be expected to result.

The difficulty of starting an epidemic of malaria, yellow fever, or trypanosomiasis (sleeping sickness) appears to be obvious, for no one has suggested the use of these agents. Those who understand the epidemiology of these diseases know they are not suited for war purposes even though they realize the problem they present to military forces in endemic areas.

This completes consideration of the communicable diseases. We have discussed in some detail practically all except the direct contact group. The only diseases of this group of great military importance are venereal, and we have given our reasons for dismissing this group from consideration.

THE INFECTIVE PROCESSES

Certain disease processes that affect the tissues are caused by living organisms and are, therefore, designated as infective, even though they are not considered communicable in the sense that they tend to be transmitted from man to man. These disease processes include such infections as tetanus, gas gangrene, anthrax, and the ordinary pyogenic (pus formers) invaders. The agents that produce these infections have all been mentioned as possible war weapons, and it must be admitted that so far as the first three are concerned, with some scientific judgment on the part of their sponsors.

The agents that cause tetanus, gas gangrene, and anthrax are not delicate organisms such as the relatively short-lived, easily destroyed pathogens that cause most of the communicable diseases. They are very resistant, spore-forming organisms, generally capable of a prolonged period of viability without loss of virulence, even when separated from the animal tissues. It is not surprising, therefore, to find one of this group (anthrax) selected as the infectious agent best suited for military purposes by a science student preparing an undergraduate thesis on "Bacteriologic Warfare."[2] The selection of anthrax does credit to his training. In fact, the entire study shows more intelligent thought than any article that has come to the attention of the writer. His description of the characteristics of the proposed bacterial invader are worth quoting:

> What shall we say are the requirements for a perfect military pathogen? It attacks preferably both man and animals. It must be quick-acting, highly virulent, and capable of causing disease in small quantities. It must be highly resistant, capable of surviving outside the body under the most adverse conditions, and even resisting partial cooking or a careless attempt at sterilization (a spore former). The causative organism should be able to force its entrance through all the avenues of infection; respiratory tract, alimentary tract, and breaks in the skin. The disease should not be too actively contagious, and it must be very well understood, for pathogens should never be used without contemplating the possibility of their getting out of control. Finally, and perhaps most importantly, it should be possible to obtain large quantities of the pathogen in virulent strain and spore form with the least possible manipulation and delay.

After this excellent description of the perfect hypothetical agent, he selects anthrax as the agent best suited to meet the requirements of a bacterial weapon. I cannot agree with Pentler that "Anthrax satisfies the requirements almost perfectly," but I believe all bacteriologists will agree that he has selected the agent that most nearly meets the requirements he has so well outlined.

These spore-forming invaders are a real problem. Tetanus and gas gangrene are pathogenic processes that have always been associated with gunshot wounds and are, therefore, of special interest to the military surgeon. They do not produce epidemic diseases, however, and they are not communicable. They have to have a portal of entry made for them, a wound, and while the use of these organisms to contaminate battlefields might cause an increase in the number of cases of tetanus and gas gangrene, they would not increase the number of casualties. They would only complicate the treatment of those already disabled. It might be added that we have an entirely satisfactory serologic prophylactic agent for tetanus, and that as a result of the surgical advances of the last fifty years, gas gangrene is less frequent than in the prebacteriologic days.

We cannot dismiss anthrax so readily; however, it is worthy of note that although anthrax is almost a world-wide disease, nevertheless anthrax infection of gunshot wounds is practically unknown. If gross contamination of battlefields with the organism of anthrax is effected, it is granted that cases of anthrax infection of wounds will occur, and possibly some few cases of infection in individuals who have not been wounded; but when we consider that human epidemic anthrax is unknown during the bacteriologic era, I question if we need fear greater danger from this organism than contamination of wounds.

It will be noted that up to this point we have not discussed the technical difficulties that a military force would have in contaminating a hostile force. The

difficulties in the case of the communicable diseases are so obvious that they need not be mentioned. The epidemiologic factors make the communicable diseases unsuited for offensive military use. The causative organisms are all either short lived when separated from the living tissues or else readily destroyed by ordinary routine sanitary precautions.

We cannot make this statement concerning the highly resistant infections such as tetanus, gas gangrene, and anthrax. These agents are admittedly the most dangerous; but it must be remembered that to be dangerous they must be alive, and that many technical difficulties present themselves when living agents are to be used that are not present when missiles and chemicals are used. Shells can be used to project missiles and chemicals on to an enemy many miles distant, but bacteria cannot be used in this way. No living organism will withstand the temperature generated by an exploding artillery shell. Airplanes may contaminate terrain, but their effect would be quite local and probably less dangerous and less certain than high explosives used in the same way.

It is not maintained that bacterial contamination is impossible. A retreating enemy may hurriedly contaminate the terrain that is to be evacuated. However, it is believed that the use of living organisms in offensive warfare presents technical difficulties that are not generally considered. The contamination that spies and other individuals could effect, using the only really effective agents we have mentioned—the highly resistant, spore-forming organisms that are so dangerous to wounds—would prove too local to be of any value whatsoever.

TOXIC PRODUCTS

The forms of bacterial warfare include not only the possible distribution of living organisms in the force of an enemy but also the possible use of toxic products derived from bacteria. Certain of our bacterial toxins are the most deadly poisons known. The toxin of the *Bacillus botulinus* is so powerful that instances have been recorded where toxins have been produced so toxic that 0.005 milligram would kill a 250 gram guinea pig. This material, botulinus toxin, is poison for man. It is possibly the most toxic agent known, and will produce the lethal effect in any way that the material is introduced into the animal. If consumed with food, injected into the tissues, or even dropped on the mucous membran or conjunctiva, it is equally deadly.

This must be the material referred to when we read such dramatic statements as the following: "An airplane can carry sufficient toxins to destroy an entire city." Such statements have an element of truth in them. In fact, they are conservative. An airplane could carry enough of the botulinus toxin to destroy every living man in the world *if* administration of the toxin was as simple a process as production and transportation.

There were over one hundred billion bullets manufactured during the World War—enough to kill the entire world population fifty times; but a few of us are still alive. It is easy to calculate the lethal (fatal) dose of a toxic agent; but do not think it is so easy to figure on the casualty-producing power of a military weapon.

The hostile aviator will not be received with a welcome, nor can he expect to land at an air field near any large city and find the entire population lined up ready to accept the carefully measured lethal dose of botulinus toxin.

The release of tremendous quantities of botulinus toxin over a large city may produce human casualties; however, the extent of the damage might be only the wholesale destruction of rodents, sparrows, and possibly numerous cats and dogs —not such a serious loss in time of war. It is difficult to evaluate properly the possible effects of the bacterial toxins. Certainly such statements as an airplane destroying an entire city with toxins is ridiculous; but they may have a value comparable to chemical agents, with this great disadvantage, however: bacterial toxins are readily destroyed by heat; therefore, like bacteria, they are unsuited for use in shells.

ANIMAL DISEASES

The use of living organisms to produce disease in livestock, such as horses and mules needed for transportation of Army equipment and supplies, has been mentioned as a possible form of bacterial warfare. It is believed that the difficulties here are quite similar to those mentioned for diseases attacking man, with this great advantage to the defense that the veterinary officer will have in controlling epidemics. The veterinary officer can destroy any animal or group that he considers a menace to the health of the animals in the Army. The medical officer cannot take such steps to control epidemics that threaten human populations.

If we expand the term bacterial warfare to embrace such phases of biologic warfare as will include the agricultural pests, then an additional factor to consider is the fact that spies, and possibly hostile aviators, might inoculate growing crops with such pests as the boll weevil, the corn borer, the Mediterranean fruit fly, and like destructive agents. These agents in most instances, however, take so long to invade sufficient terrain to be effective in destroying crops that their value in actually overcoming the resistance of a foe is questionable. They take several years to advance over a large area, and might prove an economic problem years after the war has been completed; therefore, they violate one of the fundamental ideas in warfare, since they would interfere with the ability of the conquered nation to pay the victors for the beating they had received.

CONCLUSIONS

It is believed that it has been shown that the development of implements of warfare represents an evolution based on the gradual application of the improving mind of man. The one factor of importance in this development has been effectiveness. It has been a question of the good mind versus the strong back; of the thinker verses the lifter. It is believed that the future of warfare will be based on the same principles. It is, therefore, apparent that the question of whether chemical munitions will be used or not, and whether bacterial warfare will be used or not, will depend on their practicability rather than on the sentimental reactions of pacifists.

I consider that it is highly questionable if biologic agents are suited for warfare. Certainly at the present time practically insurmountable technical difficulties prevent the use of biologic agents as effective weapons of warfare.

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CARING FOR THE NAVY'S HEALTH*

CAPTAIN LUCIUS W. JOHNSON, M.C., U. S. NAVY

FEW people had any conception of the vast, intricate organization that made up the Medical Department of the United States Navy before the blooming of the national emergency. Since that time the demands of global war have increased its scope many times, and this growth has occurred with such rapidity that one has more and more difficulty in realizing its size and complexity.

Medical service is provided on shore at recruiting stations, training stations, naval air bases, industrial navy yards, and many other activities. At sea, every ship, large or small, has its medical facilities in accordance with its prospective needs. Numerous bases in our island possessions and on foreign shores, and expeditions sent out to establish new bases, must have adequate combat medical organizations. Procurement and distribution of personnel and material to supply these requirements become a task of great magnitude. It must be remembered that the Navy includes the United States Marine Corps and, for the duration of the war, many activities of the United States Coast Guard.

The policies of the Medical Department are based on the realization that the bluejacket is the essential ingredient in Uncle Sam's struggle to survive. No matter how perfect the guns and the machines may be, the man who operates them is more important. A trained naval man is the result of a long and expensive course of selection and instruction. If one is lost to the service by sickness or injury, it is a serious matter, for his place can be filled only by another who has gone through the same long preparation. Nothing should be denied that will aid in preventing the loss of the services of a single man.

To care for the sick is an important function of the naval doctor, but he has as equal duty to prevent illness and injury. The mission of the Medical Department used to be expressed thus: "To keep as many men at as many guns as many days as possible." Wartime speed-up has now shortened this to: "Keep 'em well." Special effort is made to prepare the doctors entering the naval service for this important phase of their duties. Many have been sent to take special courses in public health work and industrial medicine at some of our leading medical colleges. Others have gone to the Naval Medical School for instruction in naval hygiene, tropical medicine, and other essential subjects.

ACTIVITIES ON SHORE

It is commonly believed that the hazards of the sea and of combat with the enemy are the principal dangers that confront the man of the Navy, but this is

*For reasons that the reader will understand, definite statements concerning the size and location of naval activities have been avoided.

The ideas and opinions here expressed are the private views of the writer and are not to be regarded as the policy of any government department.

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far from true. The accidents and diseases of the civil community have provided the greatest menace to his welfare. For example, during the last few years motor vehicle accidents on shore have been the greatest cause of death of Navy men, far exceeding drowning. There are many indications that this trend will be changed for the duration of the war.

Transplanting young men from their home towns to new communities for training exposes them to contagious diseases against which they have little immunity. It has been found good practice not to send them aboard naval ships until they have passed a few weeks under medical observation.

The bluejacket's first contact with the doctor is at the recruiting station, where he undergoes his preliminary physical examination. From then on, throughout his naval career, he is under medical surveillance. Forty years ago, Gatewood expressed the opinion that the Navy should keep its very best doctors on duty at the recruiting stations, so that they could detect men having latent defects or diseases, and so exclude them from the service. By doing this, he wrote, the dangers of syphilis and other transmissible diseases could be greatly reduced. The difficulties of accomplishing this are obvious, but it still sounds like an excellent idea. Today, the recruit has his blood tested and an x-ray film taken of his chest, while the psychiatric examination takes on increasing importance.

At the training station a careful medical observation of the recruit is made to detect any hidden defects and to discover contagious diseases in their early stages. Here he receives protective inoculations against a number of diseases, and undergoes a rigorous course of physical training which is designed to uncover any concealed weaknesses. His mental reactions are carefully studied to determine whether or not he can be molded to fit into an organization whose prime need is teamwork.

A concise description of the odd number who cannot work with others is contained in Lafcadio Hearn's statement that the Samurai class in Japan had the right and the duty to behead instantly any inferior person whose conduct was "otherwise than expected." We do not yet dispose of men with schizoid tendencies in this summary manner, but we do try to identify them and determine their potentialities, so that we can employ them where they will be most useful and will do the least harm.

Our industrial navy yards have expanded enormously in size, and many of their departments are working night and day. This imposes a greater mental and physical strain on both shop and office workers. New methods and new materials are constantly being introduced, and they bring with them new industrial hazards which, at first, may be imperfectly understood. It is the duty of the medical officers attached to the yard to study these new developments and to find out what can be done to reduce their menace. At mine and net depots, submarine bases, ammunition depots, aviation training stations, and other naval plants the medical man must be on the alert to detect and alleviate harmful industrial conditions.

Medical establishments are provided at all naval and Marine Corps bases. Those at air bases, navy yards, Marine barracks, and training stations are usu-

ally called dispensaries; it requires special authority from Congress to designate one as a naval hospital. Before our entry into the war several of these dispensaries were complete hospitals with as many as 200 beds. Since then there has been a great increase in their size and number. In staff, equipment, and professional standards, naval dispensaries are equal to hospitals of similar size in civil communities. They provide medical care not only for men of the armed services, but also for civilian employees who are injured or become sick while at work.

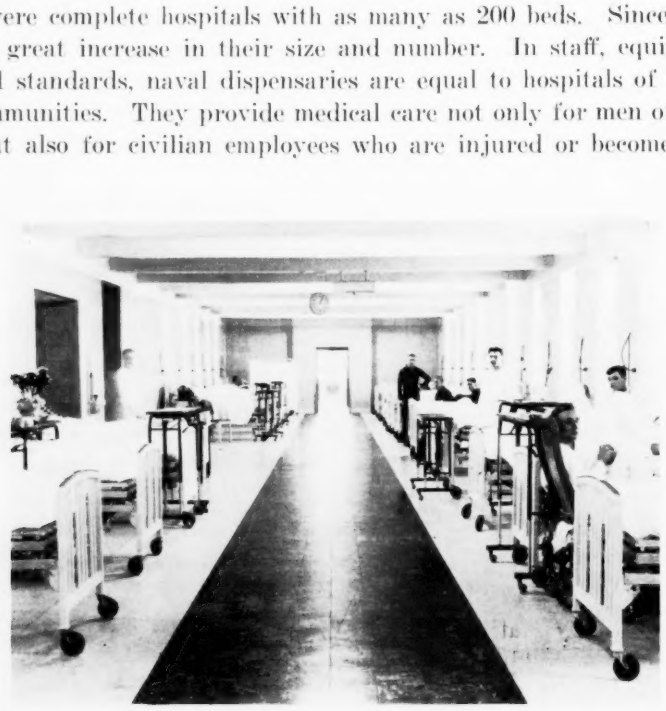

Fig. 1.—One of the wards in a naval hospital. Nursing is done by men of the Hospital Corps, supervised by women of the Navy Nurse Corps.

Naval hospitals are located at strategic points along our coasts, usually near the larger naval bases. Several new ones have been recently built or acquired, and the old ones have been the scene of great activity in the effort to expand them rapidly enough to meet the demands of our augmented Navy. That phase is now nearly completed, and we have time to concentrate on the work of perfecting the equipment and the standards of professional work in our naval hospitals.

Before the present struggle began, hospitals enjoyed an almost complete immunity from hostile attack under the Red Cross flag. In this era of total war they have become special targets, marked for destruction, because loss of hospital facilities has a damaging effect on morale, civil as well as military. The location of most of our naval hospitals, close to large industrial and military establishments, makes them especially vulnerable, and so careful consideration is being given to the need for hospital facilities located farther inland, where the danger of attack would be less. Protection of the existing hospitals is now receiving a great deal of attention. Every necessary step is being taken that will enable them to carry on their work during and after an enemy attack.

ACTIVITIES IN SHIPS AND OVERSEAS

Each of the larger ships of the Navy has its own hospital. Back in the days of Lord Nelson, the increasing weight of armament required that the new

wooden line-of-battle ships be of much heavier construction. This left deep bays on each deck, between the massive timbers. In one of these the hammocks for the sick were slung, and it acquired the name of "sick bay." That term is still used to designate the ship's hospital. A large ship, such as an aircraft carrier, may have as many as 50 to 60 bunks in her sick bay, in addition to an isolation ward, dental clinic, and doctors' offices. Her operating room is as completely equipped as that in a large city hospital. Provision can be made for any necessary operation on any part of the body. On her staff there might be as many as 7 doctors, at least one of whom would be a skilled surgeon. One or more dental officers would form an essential part of the medical staff.

Fig. 2.—A class in chemistry at a Hospital Corps Training School. Many of these men become skilled technicians.

Since there are no accommodations for women on our warships, nursing is done by enlisted men of the Hospital Corps. They are carefully selected from the better-educated recruits, and must have temperaments adapted to the care of sick persons. After their course at the training station is completed, they are sent to Hospital Corps training schools for instruction in their special work. From there they are sent to our larger naval hospitals for a period of practical work in the wards and clinics. Here they are taught by naval doctors and by women of the Navy Nurse Corps. The latter are all graduates of recognized schools of nursing; the Navy does not train any of its nurses.

Many of the men of the Hospital Corps become highly-skilled technicians in the various medical specialties. An index of the success of their course of training is found in the constant demand for navy-trained men when their enlistments expire. Large industrial organizations desire them for male nurses, first-aid

men, and technicians in laboratory, x-ray, or other special work. Throughout the Navy they provide a very satisfactory nursing and technical service.

Smaller ships, such as destroyers, have a man of the Hospital Corps attached to each, while the mother ship of the group has a large sick bay with medical and dental staff, and complete clinical facilities. It is the purpose of the Medical Department to bring its services close to every man of the Navy and Marine Corps, no matter how distant he may be, or how small the unit to which he is attached. One of the important factors in maintaining the morale of small organizations in remote locations is the assurance that a sick or injured man will have adequate medical attendance.

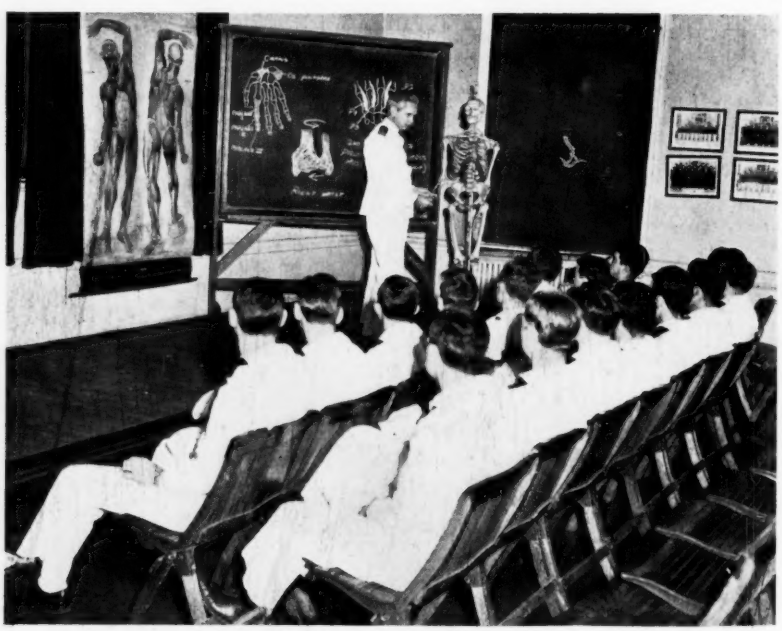

Fig. 3.—Class in anatomy at a Hospital Corps Training School.

Expeditionary forces are an important feature of the Navy's work. The Marine Corps is a unique, amphibious outfit, designed to act as a spearhead that can be advanced with great rapidity over long distances, to seize and hold advanced bases. This highly specialized duty requires the medical organization and equipment to be carefully planned, so that the doctor may be there with his necessary materials at the critical moment. To many medical officers this is the most interesting phase of the Navy's work. Many ingenious plans and gadgets have been devised by various medical officers during their study of the problems of expeditionary duty.

Many new and intricate problems of public health are imposed by the Navy's recent occupation of bases on foreign shores. At several of these, the prevalent diseases of the local people may be a greater danger than any action of the enemy. Problems of food, clothing, and living conditions must be studied, and unsanitary conditions must be corrected before the fighting forces can maintain their highest combat efficiency.

Our Navy is undergoing a precipitate change in character as a result of the lessons of recent months, with the air force becoming the dominant branch. This places on the Medical Department the obligation to develop ways and means of providing medical care under the changing conditions. New hazards and new difficulties are being encountered almost daily, so that an enormous amount of research is required to define the new problems and to find solutions for them. Many medical officers are now under training in the important specialty of aviation medicine, and the aid of some of the ablest scientists in the country has been obtained for research in the medical problems of flight.

Fig. 4.—The new buildings of the Naval Medical Center, at Bethesda, Maryland, were recently dedicated by President Roosevelt.

NAVAL MEDICAL INSTITUTIONS

First among these is the Naval Medical Center, located in Bethesda, Maryland, a suburb of Washington. The magnificent new buildings which house its many activities have recently been dedicated to their beneficent purpose. The group includes the Naval Hospital, Naval Medical School, Naval Dental School, the research activities, and schools for training technicians in many special branches. The buildings were designed and equipped to equal the facilities of the best hospitals and professional schools throughout the country. Since all medical and dental officers enter the Navy after they have completed their professional education, these schools offer postgraduate courses.

Before the rapid expansion of the Navy began, it was the policy to send newly commissioned medical and dental officers to these schools to learn the ways of the service, and also to receive instruction in several specialities which are of little interest to the general practitioner, but are of vital importance to the naval doctor. These included naval hygiene, tropical medicine, emergency surgery, public health work, and an outline of the problems of diving, aviation, and submarine work.

Development of naval hospitals has been rapid since we entered the war. New ones have been taken over, and the old ones have been greatly enlarged. They are staffed and equipped so that the patients may have everything and every care that may be helpful in their recovery. It is the aim of Admiral McIntire, our Surgeon General, to have the equipment and the professional services in naval hospitals equal to the best that can be found anywhere in the country. Nothing is spared that will aid in accomplishing this purpose.

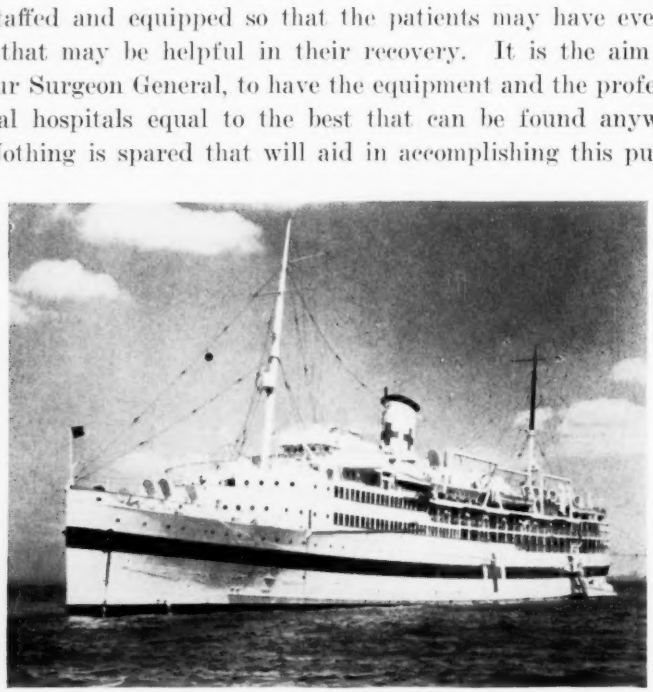

Fig. 5.—U. S. S. Solace, one of the hospital ships that accompany the fleet. She was commissioned in August, 1941.

Floating hospitals perform an important function in our Navy. If you can imagine a force of 50 or more ships, with 45,000 men, shoving off from its base for prolonged operations in distant waters, you will realize that it requires hospital facilities at least equal to those of an industrial city of that many people. Hospital ships have the staffs and equipment that will provide complete service in all the clinical specialties, and they are also prepared to act as public health laboratories. They serve the fleets at their bases, and they are able to accompany them when they proceed on their distant missions.

Much attention has recently been devoted to mobile hospitals, and they have proved their value in several combat areas. They are hospitals of several hundred beds, designed, staffed, and equipped so that they may be quickly moved by land, sea, or air, and rapidly set up when the new location is reached. Their purpose is to serve advanced bases, and to furnish hospital facilities as soon as possible after an expedition to a remote area has landed. If required, they can send off smaller units to serve subsidiary bases. An infinite variety of methods can be employed to adapt them to the needs of special areas, or to different types of military organizations.

MEDICAL DEPARTMENT PERSONNEL

For many years the Navy obtained its medical officers by competitive examination of men from class A medical schools. More recently, selected graduates

were admitted for intern training in naval hospitals. Since the emergency dawned, reserve medical officers have been called to active duty so rapidly that they now greatly outnumber those of the regular Navy. The medical officers of the Naval Reserve were carefully selected men, outstanding members of the profession in communities all over the country. When the call to duty came, they gave up their practices, severed their profitable civilian connections, and devoted their talents to serving the needs of Navy men. This influx of new men with new ideas and new talents has been of great value to the service, for many were teachers and research workers of unusual ability. It can be safely stated that nowhere in the country is there better professional service than that provided for the bluejacket in the average naval hospital.

Fig. 6.—Medical ward in U. S. S. Relief, hospital ship, which was commissioned in 1920.

In our naval hospitals the medical officers carry a gradually increasing load of administrative responsibility throughout their careers. The young medical officer in charge of a ward is responsible for the cleanliness and good discipline of his area, as well as for the professional care of his patients. This helps to develop rivalry and a sense of pride in the appearance and functioning of the whole institution. By the time a man becomes executive or commanding officer of a hospital, he is thoroughly familiar with most of the details of the uniform system of administration. The administrative system is constantly kept up to date by adopting the best methods observed in civil hospitals.

Dentists are appreciated as very valuable members of the Medical Department team. In the old days of the Navy, if a man had enough teeth to pass the physical examination for enlistment, he received no further official attention. It is different now. Every effort is made to put the teeth of every man in first-class condition during his period of training, and to maintain them in that con-

dition throughout his time in the service. An infinite amount of suffering is thus prevented.

The dentist in the Navy performs many other important functions. He is usually called upon to collaborate in the treatment of fractures about the face and jaws, and frequently assists in operations in this field. His special training in regional anesthesia enables him to give the general surgeon much-needed aid in many cases. During the pioneer work with Naval Mobile Base Hospital No. 1, the dental officer was of invaluable assistance and performed with enthusiasm many duties far outside his professional field. At Pearl Harbor and other combat areas, the first-aid work done by the dental officers has received the highest praise. Reserve dental officers, like their medical colleagues, have reported for active duty in great numbers, and are gladly welcomed as an important addition to the staffs of naval activities.

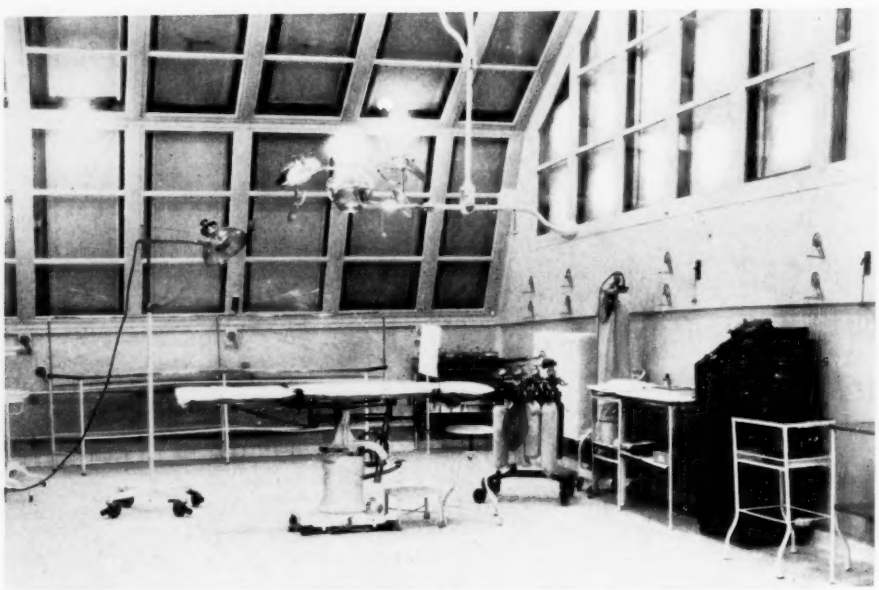

Fig. 7.—Port side of the operating room, U. S. S. Relief. Operations can be done while at sea, just the same as in port.

The Navy Nurse Corps is composed of female graduates of recognized nursing schools, who undergo careful scrutiny and selection before being appointed. The reserve nurses were organized with the aid of the American Red Cross. In our naval hospitals these women maintain a very high standard of nursing service. They also perform a very valuable function in training the men of the Hospital Corps. The obligation of our naval hospitals to provide well-trained corpsmen for duty on ships and at remote bases is second in importance only to the care of patients. A bill has recently been passed and approved which gives to nurses in the Navy increased pay and a definite status as officers. This is a well-merited recognition of their valuable service to the Navy.

Pharmacists are men who have served for many years in the Hospital Corps. They have long been restricted to warrant grades, but recently authority has

been given for their advancement to commissioned ranks. Their duties have little to do with pharmacy, but are more concerned with property and accounting, commissary, and personnel work. They are invaluable administrative aids, and no commanding officer could wish for a greater blessing than to have two or three old-time naval pharmacists on his staff.

Men of the Hospital Corps have frequently been spoken of as the most versatile men to be found anywhere, and there is ample justification for this. They are trained in nursing and the technical specialties of the medical field. Service with the Marines teaches them the use of tools and weapons, and develops their ability to take care of themselves in the field under all sorts of conditions. Duty on board ship gives them some knowledge of many mechanical trades, as well as an understanding of nautical life. Clerical work and accounting are also a part of their training. The result of all this is an alert, well-disciplined man, who is fitted to make his way in life, and to be a useful member of any organization.

An outline has been presented of the means by which the Medical Department of the Navy acts to perserve the health of its men and to care for those who are sick or injured. A severe test of the efficiency of the organization was provided by the surprise attack at Pearl Harbor, December, 1941. It is gratifying to be able to state that the preparations were found to be adequate. The Naval Hospital, the hospital ship, and Naval Mobile Base Hospital No. 2 were able to care for all the naval casualties without having to call for outside aid. Disinterested observers, who later examined the injured, spoke with praise of their excellent condition. They stated that never before had a large number of seriously-injured persons made such favorable progress.

If the general public, and especially the relatives and sweethearts of men in the Navy, could know what complete and elaborate preparations are made for conserving their health, it would be a great solace to them. Uncle Sam neglects nothing that will aid in preserving and restoring the health of the men of his Navy.

THE DEFINITION AND SCOPE OF NAUTICAL MEDICINE

CAPTAIN LOUIS H. RODDIS, M.C., U. S. NAVY

MOST civilian medical men realize that nautical medicine is a specialty which is as definite and distinct as the other professional medical specialties and that a specialist in naval medicine occupies a particular field as much as does a specialist in pediatrics or surgery.

The terms "nautical," "maritime," and "naval medicine" are three terms which are often considered as synomous. This is perhaps true of nautical and maritime medicine. Naval medicine, however, has a somewhat different meaning. Nautical or maritime medicine may be defined as that branch of medical science which has to do with the prevention and treatment of diseases and injuries peculiar to maritime or nautical life. Naval medicine may be defined as that branch of nautical medicine which is particularly concerned with diseases and injuries incident to both life at sea and naval warfare.

One of the subjects of special importance to the seagoing doctor is that of naval hygiene, which includes problems connected with ventilation; air conditioning; heating; waste disposal on board surface ships, submarines, and closed cabin aircraft. Other subjects of study are physical changes in relation to rapid changes in climate, an important matter in maritime medicine, where a man may be in a polar latitude one week and the temperate zone or tropics a short time later; the question of water supply at sea; production of fresh water from sea water or from the moisture of the air; bacteriology of the air at sea and the bacteriology of sea water; the care of the sick and injured aboard ship; the structural feature of the ships in relation to health; the control of disease vectors aboard ship; the study of epidemiology as affected by living conditions aboard ship and the prevention of diseases under conditions of shipboard life; the study of such a particularly nautical disease as seasickness and injuries from special nautical hazards, such as falls from masts and down hatches, injuries from handling boats, anchors, and similar accidents of nautical life; wounds inflicted by fish and marine animals; inspection and preservation of food for ocean voyages; proper rations, including special emergency rations for planes, boats, and submarines; and the transportation of the sick and wounded aboard ship, from ship to ship, and from ship to shore.

To such problems as these are added additional ones which may be considered as peculiar to navies and pertaining to naval medicine. Such are the physical standards of physical examinations for entrance into the naval service; the caring for wounded in battle and after battle; the disposition of battle dead; the employment of ambulances and hospital ships and of hospital and ambulance planes; the study of first-aid materials for the individual soldier and sailor; the tactical employment of medical troops with expeditionary forces and landing parties; the treatment of gas casualties; postgraduate training of med-

ical officers and the training of hospital corpsmen and technicians; the maintenance of naval hospitals and naval medical supply depots; the obtaining of drugs and medical and surgical supplies and equipment for use on ships and at naval hospitals; the disposition of cases with permanent disabilities and pensions; the caring for the tubercular and the insane of the Navy; the questions of naval medical history and of naval medical organization and administration; the uniforms and insignia of the medical department of navies; the practice of pharmacy and dentistry in navies and of the utilization of female nurses in naval establishments. All these represent problems and fields in naval medicine, and the naval medical officer must be cognizant of them and know something about them. Training and experience are needed to obtain this knowledge just as in other specialist branches of medicine.

The naval medical officer must be an excellent general practitioner. Often he is in isolated places or the only medical men on a ship in the middle of a large ocean. The medical problems of the men and officers of that ship must be solved by him and him alone. He cannot turn to a specialist or refer a case to a surgeon, an eye, ear, nose, and throat specialist, or a dermatologist just across the street. He must deal with the case himself. I do not mean by this that specialism is not needed in the Navy. As a matter of fact, every specialty must be represented and in the hospitals, and places where definitive treatment can be given specialists in every specialty must be available. I wish, however, to emphasize the point that the naval surgeon must be a good general practitioner first of all, with some definite knowledge of naval medicine. It is said that the specialty of the general practitioner in civil life is obstetrics. I would say that the specialty of the naval surgeon is naval medicine and that both preventive medicine and traumatic surgery form essential features of his specialty.

The versatility of the naval surgeon and the men of ability which his specialty has attracted is shown in the history of nautical medicine. Many of the greatest names in medicine and science have come from the ranks of naval surgeons: James Lind, Sir Gilbert Blane, Linnaeus, Darwin, and Huxley were naval surgeons. The founders of tropical medicine were naval surgeons. Even the surgeon of a crew of buccaneers is known to every medical man today who prescribes Dover's powder. The history of medicine, indeed, owes much to the seagoing medical man.

ADAPTATION OF TECHNICIAN INSTRUCTION TO THE MILITARY EMERGENCY*

MAJOR JACK W. LOVE, M.C., CAPTAIN I. ROTHSTEIN, M.C., AND FIRST LIEUT. J. CEBEL, M.A.C.

CONSIDERABLE interest has been shown recently in the type of training given to enlisted men in the United States Army to equip them to work as laboratory technicians. This interest, apparently, has been stimulated by the realization that we have only a period of twelve weeks in which to prepare these students to assume the many responsibilities of a laboratory technician. It is our purpose to outline the working schedule of training, and we trust that inspection of it will indicate the scope, objective, and methods of instruction used in this course.

The Laboratory Section of the School for Medical Department Technicians has a teaching staff of three full-time officer instructors, one staff sergeant, one sergeant, and three enlisted specialists who act as assistant instructors. As part-time assistant instructors there are other more technically trained specialists who contribute their services during certain periods of the course. The technical background of the staff has been largely acquired in the field of clinical pathology, including the various specialties.

As the training schedule is unfolded, one will readily see that in order to cover the various subjects within the three-month period allowed for this course, there must be a sacrifice of either the formal didactic lectures or the practical "bench work" training. Consequently, in order to have the student derive the utmost from the course, it is so arranged that there is a minimum of lectures; these consist of outlining the particular work to be covered for that day, stressing the salient features and placing emphasis on the more important aspects involved in the performance of the test. The student's interest and proficieney are maintained at a high level by occasionally introducing the clinical application and interpretation of the routine procedure.

In order to fit this course into a period of twelve weeks, the hours of instruction are from 8:00 A.M. to 4:00 P.M., with an hour for lunch at noon. Saturday afternoons and Sundays are given as rest periods, and extra time in the laboratory at night is discouraged except for those students who cannot keep up this rapid pace. This results in a total of 460 hours of training, with the allotment as follows:

*From the Laboratory Section of the School for Medical Department Technicians, Army Medical School, Washington, D. C.

a. Basic Technique	57 hours
b. Hematology	60 hours
c. Parasitology	57 hours
d. Bacteriology	108 hours
e. Histologic Technique	48 hours
f. Chemistry	90 hours
g. Serology	36 hours
h. Advanced Hematology	4 hours
	460 hours

Tables I-III show the daily program divided into three four-week periods following in direct sequence.

Basic Technique.—As this subject implies, each student is instructed in the simpler routine laboratory procedures which are essential in the maintenance and care of supplies and equipment used in clinical pathology. The student is taught to clean glassware properly and to acquaint himself with the various methods of sterilization. He is taught the preparation of stains and solutions, the simpler technique of inoculating solid and liquid media, the transferring of cultures, staining of bacteria, and the making of the so-called "wet" preparations for study. Here the practical "bench work" method of instruction consists of allowing each student to perform this work under proper and adequate supervision.

Hematology.—The object in this part of the course is to train the student to perform a simple blood count with accuracy. The expression "simple blood count" includes the hemoglobin determination, the erythrocyte and leucocyte counts, and the differential white cell tabulation. In regard to other hematological procedures, such as the platelet count, reticulocyte count, peroxidase differential stain, bleeding and coagulation times, only a minimum amount of time and instruction are given in order to give the student merely an insight into these procedures so that each can be performed under supervision. In the second four-week period, four hours of instruction are given in advanced hematology. This time is devoted to demonstrations of the various blood disorders in conjunction with enough didactic instruction to orient the student with regard to the important blood disorders and to help him realize the necessity of assistance from the laboratory director when abnormal cells are encountered during the performance of a simple blood count.

Serology.—The beginning part of this subject is devoted to both demonstration and practical application of venipuncture technique, of the separation of sera from blood specimens, and of setting up both blood typing and crossmatching tests along with their interpretation. The more detailed serologic procedures consist of repeatedly performing the standard and quantitative Kahn tests for the diagnosis of syphilis. In addition, the student is taught to prepare colloidal gold solution and to perform several colloidal gold tests on spinal fluids. The Kolmer complement fixation test for syphilis is also demonstrated.

Histologic Technique.—In this course each student is taught the proper care of the equipment used in the preparation of tissue for histologic examination; this includes the care and sharpening of the microtome knife. Instruction is given in tissue fixation and embedding, and sectioning of tissue with both the paraffin and frozen section methods. In the more advanced part of this train-

TABLE I

FIRST FOUR-WEEK PERIOD

LABORATORY TECHNICIAN TRAINING—S.M.D.T.

8-12 A.M.	*1st Day* Hematology	*2nd Day* Hematology	*3rd Day* Hematology	*4th Day* Hematology	*5th Day* Hematology	*6th Day* Examination in Basic Training
	Hemoglobin determination	White blood cells	Errors in differential counts	Blood cell counts	Errors in red and white cell counts	
	Technique of finger puncture	Blood smears, staining, differential count	Errors in hemoglobin determination	Calculation of red and White cells		
	Practical—application of above	Practical—application of above	Practical—differentials	Practical—complete blood count	Practical—two complete blood counts	
1-4 P.M.	Basic Training	Basic Training	Basic Training	Basic Training	Basic Training	
	Outline of course Laboratory rules Care of equipment	Cleaning glassware Cleaning—Pipettes, syringes needles, etc.	Plugging glassware Wrapping glassware Cleaning new glass	Use of thermometer Fahrenheit scale Centigrade scale	Glass bending Glass cutting Capillary pipettes	
8-12 A.M.	*7th Day* Hematology	*8th Day* Hematology	*9th Day* Hematology	*10th Day* Hematology	*11th Day* Hematology	*12th Day* Examination in Basic Training
	Review—blood counts and calculations	Blood platelets determination importance	Errors in platelet determination	Reticulocyte Determination, supravital staining	Errors in reticulocyte counts—review	
	Practical—two complete blood counts—reports	Practical—blood platelet determination	Practical—blood count, differential, platelet determination	Practical—reticulocyte Determination, calculation reports	Practical examination on complete blood counts	
1-4 P.M.	Basic Training	Basic Training	Basic Training	Basic Training	Basic Training	
	Sterilization of tongue depressors, throat swabs	Use and care of laboratory animals Inoculation of above	Elementary chemistry Symbols, elements, compounds Use of balance	Solutions—saturated, dilute and normal preparation of solutions	Culture media—preparation, adjustment of reaction, storage	

8-12 A.M.	*13th Day* Hematology Errors in examinations Abnormal red cells Practical—blood counts with cautions against errors made in examination	*14th Day* Hematology Peroxidase reaction Use and performance Method of reporting Practical—application of peroxidase reaction	*15th Day* Hematology Coagulation time Bleeding time Practical—application of above	*16th Day* Hematology Review of high points of complete course Practical—review of blood study procedures	*17th Day* Hematology Final examination Practical—W.B.C., R.B.C., color index, hemoglobin determination, and differential	*18th Day* Examination in Basic Training
1-4 P.M.	Basic Training Preparation of media, infusion broth, extract agar, E.M.B. plates	Basic Training Prepare blood agar slants and blood agar plates	Basic Training Demonstration of motile and non-motile bacteria Hanging drop and wet preparations	Basic Training Staining—Gram's stain Loeffler's stain Preparation of dyes for stains	Basic Training Practice in staining Bacteria using Gram's stain Bacteria of sputum, feces	
8-12 A.M.	*19th Day* Chemistry Urine collection constituents of urine Practical—physical and chemical examination	*20th Day* Chemistry Organized and unorganized sediments in urine Practical—microscopic examination of urine	*21st Day* Chemistry Importance of routine urinalysis Practical—complete urinalysis	*22nd Day* Helminthology Classification of worms Life cycles and habitat Practical—examination of unknown feces for eggs	*23rd Day* Helminthology Wet preparations Practical—examination of unknown feces	*24th Day* Final examination in Basic Training Helminthology continued
1-4 P.M.	Basic Training Inoculation of Media Pure cultures supplied	Basic Training Isolation of pure cultures of bacteria from mixed cultures Morphological and cultural characteristics	Basic Training Collecting of specimens and preparation for shipment Practical—application of above	Serology Venipuncture Use of necessary instruments Practical—each man does a venipuncture	Serology Blood typing—importance, method, classification Practical—application of above	

TABLE II

SECOND FOUR-WEEK PERIOD

LABORATORY TECHNICIAN TRAINING—S.M.D.T.

8-9 A.M.	*1st Day* Histology General introduction Fixing fresh animal tissue	*2nd Day* Histology Tissue fixing Introduction to staining eosin, etc.	*3rd Day* Histology Further work with eosin and hematoxylin	*4th Day* Histology Paraffin Embedding, further fixing and staining	*5th Day* Histology Paraffin Embedding and further staining	*6th Day* Histology Paraffin embedding and further staining
9-12 A.M.	Helminthology Review—charts and slides, etc. Practical—examine three unknown feces	Parasitology Characteristics of amebae, importance Practical—*E. coli, E. histolytica*	Parasitology Examine feces with cysts Examine cultures with trophozoites	Parasitology Examination—feces containing helminth eggs and amebic cysts	Parasitology Blood and tissue flagellates—*giardia Trichomonas, Leishmania*	Parasitology Malaria—life cycle, importance, *P. vivax* Practical—examine slides
1-4 P.M.	Serology Cross matching Blood transfusion Practical—blood typing, cross matching	Serology Serological tests Care of glassware Practical—wash glassware	Serology Kahn test, antigen reagents, technique Practical—run a Kahn test	Serology Examination—venipuncture, blood typing, cross matching	Serology Serological forms Shipment of specimens Practical—each man will run 6 Kahn tests	
8-9 A.M.	*7th Day* Histology Further embedding and staining Introduction to decalcification	*8th Day* Histology Embedding, staining, and decalcification	*9th Day* Histology Paraffin embedding, decalcification Study of animal tissues	*10th Day* Histology Introduction to celloidin method Further work in decalcification	*11th Day* Histology Further work in study of animal tissues Further work in the celloidin method	*12th Day* Histology Further work in celloidin embedding, tissue study, paraffin embedding
9-12 A.M.	Parasitology Malaria—compare *P. Vivax* with *P. Malariae* Practical—examine slides of *P. Malariae*	Parasitology Malaria—*P. falciparum,* importance Practical—examine slides of *P. falciparum*	Parasitology Review—all types of malaria with unknown slides Demonstration set up	Parasitology Entomology—roles played by insects, mosquito Practical—study anatomy of mosquito	Parasitology Conclude study of mosquitoes started the previous day	Parasitology Fleas, ticks, lice, bedbugs, etc., medical importance Practical—study set up exhibit
1-4 P.M.	Serology Spinal fluid Kahn Quantitative Qualitative Practical—run a	Serology Colloidal gold preparation Practical—each man	Serology Read test set up previous day—report	Serology Review complement fixation test Practical—each man	Serology Final written examination in serology	

1-4 P.M.	Serology Spinal fluid Kahn Quantitative Qualitative Practical—run a spinal fluid Kahn test	Serology Colloidal gold preparation Practical—each man will run two colloidal gold tests on spinal fluid	Serology Read test set up previous day—report Demonstrations in Serology Department	Serology Review complement fixation test Practical—each man will read 15 colloidal gold tests	Serology Final written examination in serology	
8-9 A.M.	*13th Day* Histology Further work in celloidin embedding Cutting paraffin sections	*14th Day* Histology Celloidin method Cutting of paraffin sections	*15th Day* Histology Cutting of paraffin sections and further tissue study	*16th Day* Histology Introduction to cutting and staining frozen sections	*17th Day* Histology Cutting and staining frozen sections	*18th Day* Histology Cutting and staining frozen sections
9-12 A.M.	Parasitology Study various types of flies—their medical importance Practical—study fly exhibit	Parasitology Review of entire course Practical—examine unknown stool and blood specimens	Parasitology Final examination covering unknown stools, slides, and demonstration	Bacteriology Classification of bacteria—*Staphylococcus albus* and *aureus* Practical—streak blood plates, make Gram stain	Bacteriology Examine plates made previous day, cultural characteristics Streak blood plates with *Staph. pyogenes* and *Staph. salivarius*	Bacteriology Examine plates made previous day Characteristic Gram's stain of organisms
1-4 P.M.	Hematology Anemias of all types Polycythemia Purpuric—hemorrhagic diseases	Hematology Leucemia—acute and chronic types Bone marrow studies, etc.	Chemistry Quantitative examination of urine	Chemistry Quantitative examination of urine	Chemistry Quantitative examination of urine	
8-9 A.M.	*19th Day* Histology Introduction to Giemsa's staining for bacteria	*20th Day* Histology Further work with Giemsa's stain for bacteria	*21st Day* Histology Cutting and staining celloidin sections	*22nd Day* Histology Cutting and staining celloidin sections	*23rd Day* Histology Practical examination Identification of tissues	*24th Day* Histology Written examination on technique procedures
9-12 A.M.	Bacteriolgy Technique of blood cultures Practical—make a blood culture	Bacteriology *D. Pneumoniae* Identification Inoculation of plates Neufeld reaction	Bacteriology Study *D. pneumoniae* Bile solubility test Examine blood plates for type of colony	Bacteriology Genus *Neisseria* Inoculation, Gram's stain, characteristics Diagnosis	Bacteriology Examine plates of Neisseria organisms Examine smears from acute cases	Bacteriology *N. intracellularis* characteristics Polyvalent and type agglutination test
1-4 P.M.	Chemistry Quantitative Examination of urine Examination	Chemistry Gastric analysis introduction Physiology, motion picture	Chemistry Gastric analysis Titration of gastric contents	Chemistry Gastric analysis Titration of gastric contents	Chemistry Gastric analysis examination—titration of unknown gastric contents	

TABLE III

THIRD FOUR-WEEK PERIOD

LABORATORY TECHNICIAN TRAINING—S.M.D.T.

8-9 A.M.	*1st Day* Histopathology Bacterial staining Giemsa stain	*2nd Day* Histopathology Bacterial staining Giemsa stain	*3rd Day* Histopathology Bacterial staining Giemsa stain	*4th Day* Histopathology Bacterial staining MacCallum's stain	*5th Day* Histopathology Bacterial staining MacCallum's stain	*6th Day* Histopathology Bacterial staining MacCallum's stain
9-12 A.M.	Bacteriology Read agglutination tests previously set up Examine G. C. slides Examination	Bacteriology Water examination technique, importance Practical—run a water examination	Bacteriology Continuation of water analysis and counting of colonies	Bacteriology Autogenous vaccine and its application Continue water analysis	Bacteriology Continue water analysis—milk analysis—test on vaccine	Bacteriology Milk count and complete water analysis Make final report on vaccine sterility test
1-4 P.M.	Blood Chemistry Preparation of chemicals used in blood chemistry	Blood Chemistry Completion of solutions, make up Nessler's reagent	Blood Chemistry Calorimetry—explained and applied	Blood Chemistry Blood filtrate preparation Sugar determination	Blood Chemistry Nonprotein nitrogen determination	
8-9 A.M.	*7th Day* Histopathology Fat staining Sudan iv	*8th Day* Histopathology Fat staining Sudan iv	*9th Day* Histopathology Fat staining Sudan iv	*10th Day* Histopathology Fat staining Sudan iv	*11th Day* Histopathology Tubercle bacillus staining Mallory's method	*12th Day* Histopathology Tubercle bacillus staining Mallory's method
9-12 A.M.	Bacteriology Gram-negative enteric bacilli Inoculation of *E. typhosa*, para A and para B	Bacteriology Identification of pathogenic enteric bacilli—procedure	Bacteriology Further work with enteric bacilli inoculation cultures	Bacteriology Further work with enteric bacilli Examine cultures	Bacteriology Further work with enteric bacilli Agglutination tests	Bacteriology Food poisoning Read agglutination tests previously set up

1-4 P.M.	Blood Chemistry Urea nitrogen, uric acid, creatinine determinations	Blood Chemistry Urea clearance Collection of specimens	Blood Chemistry Urea clearance determination	Blood Chemistry Glucose tolerance test and determination	Blood Chemistry Sulfonamide chemistry Sulfanilamide determination	
8-9 A.M.	*13th Day* Histopathology Iron hematoxylin stain for fibrous tissue	*14th Day* Histopathology Iron hematoxylin Stain for fibrous tissue	*15th Day* Histopathology Weigert's stain for elastic tissues	*16th Day* Histopathology Mallory's phosphotungstic stain for fibrous tissue	*17th Day* Histopathology Mallory's phosphotungstic stain for fibrous tissue	*18th Day* Histopathology Mallory's phosphotungstic stain for fibrous tissue
9-12 A.M.	Bacteriology Prepare antigens Set up agglutination tests made with above antigen Examination	Bacteriology *Vibrio comma* Inoculation of nonpathogenic *V. Comma*	Bacteriology Further work with *V. Comma*—genus Brucella	Bacteriology Spore-forming bacteria genus *bacillus* Aerobic culture methods	Bacteriology Spore-forming bacteria genus *Clostridium* motility tests	Bacteriology Spirochetes—*Treponema*, *Leptospira* and *C. borrelia* (Vincent's angina)
1-4 P.M.	Blood Chemistry Calcium and phosphorus determinations	Blood Chemistry Liver function test	Blood Chemistry Carbon dioxide and carbon monoxide determination	Blood Chemistry Phosphatase determination	Blood Chemistry Cholesterol determination	
8-9 A.M.	*19th Day* Histopathology Stains for hemosiderin	*20th Day* Histopathology Stains for hemosiderin	*21st Day* Histopathology Silver impregnation for syphilis	*22nd Day* Histopathology Final examination	*23rd Day* Histopathology Clean up the laboratory	*24th Day* Graduation Exercises
9-12 A.M.	Bacteriology *Corynebacterium C. diphtheriae C. xerosis*, etc.	Bacteriology Virulence test for *C. diphtheriae*	Bacteriology Mycobacterium Ziehl-Neelsen staining	Bacteriology *Mycobacterium* concentration of specimens	Bacteriology Yeasts and molds Final examination	
1-4 P.M.	Blood chemistry Serum protein determination	Blood Chemistry Clean apparatus for the final examination	Blood Chemistry Final examination Practical	Blood Chemistry Clean up laboratory Prepare solutions	Toxicology Lecture with demonstrations	

ing, the student is taught to use various stains, with their respective indications and value, although emphasis is placed on the routine hematoxylin eosin and Masson trichrome stain techniques. The hematoxylin eosin stain is used on tissues that are carried through the entire routine by each student. Naturally, in teaching tissue selectivity, a few essentials of histology are included so that the student may, to some extent, recognize the different tissues under the microscope.

Parasitology.—Throughout this entire course practical "bench work" is stressed, and the only lectures given are to guide the student in his routine work and to point out the more important features used in the identification of the various parasites. The course starts with the study of the various helminth ova, using both fixed preparations and stool specimens; then gradually the more detailed studies are added, which include identification of the malarial parasites, insects, and arthropods. Each student is equipped with a loan set of slides of fixed preparations, and considerable time is devoted to the study and practical examination of these slides.

Bacteriology.—In this course each student is familiarized with the practical aspects of bacteriologic technique, especially that part which will enable him to isolate and identify tentatively the various bacteria of medical importance. During the six weeks of three-hour periods, each of the genera is studied, with emphasis being placed on the more important species. In dealing with the more common pathogenic bacteria, a morphologic and cultural study is performed, and where indicated, differential media, biochemical, serologic and animal tests are used. The special procedures covered during this course include the performance of blood cultures, pneumococcus and meningococcus typing, water and milk analysis, agglutination tests, anaerobic culture methods, and the dark-field technique.

Chemistry.—The student is first taught the simple and practical fundamentals of chemistry. With this background, the course embraces the various phases of a routine urinalysis, including the physical, chemical, and microscopic examination, using normal and abnormal urine samples. Practical instruction is then given in titration, normal solution preparation and both are utilized in the performance of a fractional gastric analysis. The final four-week schedule has each afternoon devoted to metabolic chemistry. A large part of this scheduled time is used in the actual performance of the various metabolic determinations requested of a well-organized chemical section of a medical laboratory. In this more detailed portion of the course, it is only natural to include some of the practical working theories, but these are only dealt with from their useful and practical aspects.

Tables IV, V, VI, and VII represent graphically an analysis of twelve successive classes of students trained during the first year of this course (Laboratory Section, S.M.D.T.) of the Army Medical School. Table IV reveals that half of the students admitted were college students, college graduates, or postgraduate students. Less than 10 per cent of the students admitted had only a grade school education. Table V shows that while the number of students does not allow for statistical scrutiny, certain generalizations may be made. The average

TABLE IV

EDUCATION	NUMBER OF STUDENTS ADMITTED
Grade school	19
High school	115
College and postgraduate	135
Total	269

TABLE V

ANALYSIS OF GRADUATES

PREVIOUS LABORATORY EXPERIENCE	GRADE SCHOOL		HIGH SCHOOL		COLLEGE AND POST-GRADUATE	
	NO.	GRADES (%)	NO.	GRADES (%)	NO.	GRADES (%)
None	1	83	39	88	57	92
Up to 6 months	2	88	29	89	47	92
7 to 12 months	2	85	5	89	14	91
Over 12 months	0	0	7	91	2	92

TABLE VI

ANALYSIS OF NON-GRADUATES

PREVIOUS LABORATORY EXPERIENCE	GRADE SCHOOL		HIGH SCHOOL		COLLEGE AND POSTGRADUATE	
	NO.	GRADES (%)	NO.	GRADES %	NO.	GRADES (%)
None	12	54	25	59	10	72
Up to 6 months	2	65	3	71	4	77
7 to 12 months	0	0	6	70	1	86
Over 12 months	0	0	1	99	0	0

Average number of weeks of study: 4.1

TABLE VII

RATINGS OF TECHNICIANS	NUMBER	AVERAGE GRADE (%)
T-1 Master technician	0	0
T-2 Expert technician	1	98
T-3 Senior technician	122	93
T-4 Technician	72	87
T-5 Junior technician	10	82
Students dismissed as T-5	3	70
Students dismissed no rating	48	60
Students transferred T-5	1	92
Students transferred no rating	12	85
Total	269	

grades of the students seem to vary directly with the degree of previous education. In regard to previous laboratory experience, this factor is of considerably less significance than the amount of education in determining the progress of the student in our laboratory course. Table VI is shown merely for the sake of completeness and, since it includes among the nongraduates, students who were dropped due to illness, no conclusions will be drawn. Table VII shows that these latter students did very well up to the time of their transfer. The majority of the students graduated received a Technician 3rd Class or Senior Laboratory Technician qualification on their certificate.

Each of the ratings listed in Table VII denotes certain definite capabilities and qualifications, although it must be remembered that we only recommend the graduates for these ratings. These ratings may be summarized as follows:

MEDICAL LABORATORY TRAINING QUALIFICATIONS*

"*a.* Junior Laboratory Technician, 5th Class: A graduate of the course for laboratory technicians, Army Medical School, or an equivalent course in a civil institution or the equivalent in practical experience, and able to perform the following:

(1) Cleaning and sterilization of laboratory glassware and equipment under direct supervision.

(2) Ordinary routine laboratory procedures, such as urinalysis, blood counts, preparation and staining of slides, and care of cultures.

(3) Care of laboratory animals

(4) Preparation of routine culture media.

b. Laboratory Technician, 4th Class: Qualified as in *a* above, and able to perform the following:

(1) All routine tests on blood, urine, sputum, stools, and pus exudates.

(2) Elementary bacteriology, agglutination and serological tests.

c. Senior Laboratory Technician, 3rd Class: Qualified as in *b* above, and able to perform the following:

(1) Preparation of all stains, solutions, and media.

(2) Routine procedures in any department of a corps area or similar laboratory.

(3) The preservation, preparation, and mounting of pathological materials.

d. Expert Laboratory Technician, 2nd Class: Qualified as in *c* above, and able to perform the following:

(1) Train laboratory technicians in lower grades in the performance of routine laboratory tests.

(2) Assume technical charge of one or more divisions of a corps area laboratory or equivalent.

(3) Carry out, under supervision, more complicated laboratory tests in serology, chemistry, and pathology.

e. Master Laboratory Technician, 1st Class: Qualified as in *d* above, and able to perform the following:

(1) Special ability in one or more laboratory specialties, demonstrated during long and excellent service.

(2) Ability to take charge of any corps area laboratory or equivalent under direct supervision of an officer."

*-MTP 8-1 Medical Department Mobilization Training Program, Medical Field Service School, Carlisle Barracks, Pa., 1940, pages 16-17.

SUMMARY

1. An outline for teaching a laboratory technician course to enlisted men of the United States Army has been presented. This course has been condensed to meet the present emergency. By relying mainly on practical application and demonstration, this entire course is given in the allotted twelve weeks.

2. An analysis of the students graduating during the first twelve months reveals that the final average of grades and individual recommended ratings depend more on their educational background than on previous practical laboratory experience. The majority of students taking this course have been recommended as senior laboratory technicians on the basis of their practical knowledge and ability acquired in this work.

We wish to acknowledge the assistance given by Technical Sergeant A. J. Babalonis in compiling the statistical material.

THE GENERAL MISSION OF MILITARY AVIATION MEDICINE*

BRIGADIER GENERAL DAVID N. W. GRANT, M.C., THE AIR SURGEON, ARMY AIR FORCES

AVIATION is a comparatively new field towards which man has come to direct his energies. At first only a dream, it soon became a reality. Today it is the hobby of thousands, as well as the bread and butter to thousands more. To many it is a curse because it brings fear, destruction and death as an instrument of war. Even under the best conditions it is a calling not without its hazards, for many deaths and broken bones have been left in the wake of its progress, but it has nevertheless advanced rapidly and today can take its place among other occupations as a vocation.

Man has ever been seeking improved methods of transportation, the goal always being increased speed. Each development and improvement of means of travel have presented new medical problems. The development of aviation has been no exception. It has brought with it problems of oxygen want, acceleration, unprecedented demands on the special senses, the nervous system, the heart, and other organs.

World War 1 stimulated the first intensive interest in the medical problems involved in aviation. When the United States entered the War, it benefited greatly by the very unfortunate experiences suffered by the British in the first two and one-half years of that conflict. An analysis of Great Britain's flying casualties during that period showed that of one hundred air fatalities, only two were killed by the enemy, eight deaths resulted from defects in the plane, and ninety were due to deficiencies in the individual, either physical or mental. In those early days virtually no attention was paid to the selection of the individual who was to fly from the medical standpoint. Men were often assigned to aviation duty after they had become unfit for service in the ground arms. The wastage of personnel and material, of course, was enormous.

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Upon the entry of the United States in the War, the Medical Department was faced with the problem of overcoming all those conditions affecting the physical fitness of the man who was to go in the air. It was at once realized that everyone should not fly, and investigations were immediately begun and have been continued ever since on the problems of selection of flying personnel, and, after their selection, their maintenance in a normal condition.

The general mission of aviation medicine, that of the selection and care of flying personnel is and always has been intimately associated with National Defense. That this mission has been well accomplished is proved by the recent recognition of aviation medicine as a specialty. It is not anticipated that this mission will change, nor is it to be assumed that there will be other than minor difficulties encountered in its accomplishment even when expanded to the present scope of National Defense. *The problem of the moment, therefore, is an orderly expansion of aviation medicine in step with National Defense.* The attending difficulties encountered in any such tremendous expansion are many, but, in a general way, they fall into one of two large groups: First—Problems of personnel. Second—Problems of training.

These problems are tremendous and call for a separate discussion, not within the scope of this paper; rather will I undertake briefly to discuss the general mission of military aviation medicine, that is the selection and care of the military flier, for at this time we are faced with the tremendous problems of securing 30,000 new pilots each year, which calls for the special examination of approximately 120,000 young men. Not only must these men be chosen for their ability to learn to fly, but also from the standpoint of their ability to withstand the stress of operational flying over a long period of time. These figures do not take into account the selection of other crew members, bombardiers, navigators, gunners, and the like, totaling another 100,000.

In selection, the flight surgeon endeavors to select only those individuals for flying training who are most free from real or potential physical and mental abnormalities. The physical examination for flying is more than an objective physical survey. It is an investigation of those bodily and mental attributes, which, by reciprocal action, serve to define the individual as an entity. It has for its object an estimation of his special suitability for a task in a new environment.

Flying subjects man to unfamiliar environmental factors and places under his control a strange and powerful mechanical force which greatly taxes his resources. It creates thereby a new experience which is capable of providing an extraordinary test of his adaptability. The estimate of aptitude for new and specific tasks relies on an evaluation of the individual's entire equipment. It seeks to weigh the potentialities of body and mind and to apply them to the demands of the special situation. It considers native and acquired resources, and computes their utilization. The new task has its origin in the multitudinous needs and desires of man in his peculiar environment. It signifies a new experience, which, found useful and desirable, is retained and perhaps modified for the benefit of the individual and others. It may range in variety from the most simple to the most complex, from the elementary forms of performance to the technical accomplishments developed in the various arts and sciences.

The complexity of the task to the individual is gauged by the degree of stress which it imposes upon his resources. He may have been endowed with sufficient inherent capacity to achieve success, if he so wills, or his capacity may be so limited that achievement is impossible in spite of effort. It is, therefore, obvious that each individual is not qualified by inherent capacity or aptitude to perform the same task with an equal expenditure of endeavor and a like effectiveness.

Aviation is a complex task. It contains the finesse of an art and the exactness of a science. From a military standpoint, it should be performed with the highest degree of efficiency.

The individual for military aviation should be selected with great care. Physical fitness to combat the stresses of flying is not the only requisite. Stability of mental and nervous organization is equally important.

Experience in military aeronautical training has often demonstrated that not every student can meet the requirements of the flying task within the accepted standards. Although he has been physically qualified, is a member of the optimum age group, and has the essential educational background, he may nevertheless fail in adjustment and performance.

It must be remembered that our present physical standards for military flying are based on past experience in matters of efficiency and safety. It is known that some men with physical handicaps, such as having only one leg, or one eye, tuberculosis, or other handicaps, have made excellent pilots. However, immediate efficiency and ultimate economy unquestionably indicate the wisdom of admitting to training only the very best physical material.

In approaching the problem of selection from the psychological standpoint, it must be remembered that the term psychology does not apply to anything mythical, supernatural, or even out of the ordinary. Psychology today deals with very common aspects of human behavior, and the factors that will be mentioned here are the doings, the feelings, and the characteristics of mankind in general, all of which can be observed in ourselves and in our associates with whom we come in daily contact. That individuals differ markedly in general intelligence, in learning ability, in perceptual and memory faculty, and in emotional balance is a fact well known to us all. Those of us who have had to do with the selection of flying personnel have long been seeking to determine just what psychological make-up is necessary for military aviators. Time permits only a brief discussion of these aspects which are especially important in relation to flying.

Intelligence. When we refer to intelligence, we usually mean the capacity to deal effectively with new situations and to understand new problems by applying the results of past experience. Certainly flying is a novel situation for a human being, and in order that he may adequately meet the many problems involved, it is essential that he possess a satisfactorily high level of general ability. But experience has shown that not all individuals having normal or even superior intelligence make successful military aviators. Intelligence is a complex of many functions and two individuals having the same level of general ability may differ tremendously in the amounts of specific abilities which they possess. Learning to pilot an airplane demands a good capacity for learning, but it is learning of a specialized sort and differs considerably

from the ability to learn Greek or mathematics. At least normal intelligence should be required in all flying students. Those with less than this endowment are slow to understand instructions, do not remember, and have great difficulty in solving their problems quickly and effectively. But we need to know more about the individual's mental make-up than merely his general level of ability.

Learning and Memory. To become a military flyer, one must learn a great many things. Normal rapidity of learning and habit formation are essential if progress is to be satisfactory. As in all other things, individuals vary in their capacity to learn. Some learn quickly and forget right away; others learn slowly but remember for a long time. Undoubtedly, the person who learns quickly and retains well the specific knowledges, skills, and attitudes of the types required for military aviation will inherently be the best qualified.

As a result of learning meaning is given to one's experiences. This understanding and interpretation of stimulation of the senses are known as perception, and simply mean that we understand a situation at a glance because we have learned the meaning of this and that stimulus. Good perception is of the utmost importance to the pilot; in fact, it is absolutely essential. He must use his space-perceiving apparatus almost continuously and to the greatest degree. He sees the ground below, and with experience learns much and perceives many things that are meaningless to one who makes his first airplane trip, such as approximate altitude of the airplane, character of the terrain, direction of the wind, and others.

In flying the time factor is all-important. The speed with which the various maneuvers must be learned and co-ordinated is definitely related to the speed of the aircraft. Many of the responses of the pilot must be learned so well that they become almost automatic in nature, and not just a memorized method of movements of stick, rudder and throttle. Extreme delicacy and discrimination are essential, correct interpretation is demanded, and sound reaction must be initiated with a maximum of speed. When material is poorly learned, or when one's memory errs or falters, one cannot effectively respond, and too often penalties are exacted for failure. It should be apparent then, that normal rapidity of learning and habit formation is necessary in a flyer. This includes a plastic learning faculty to permit quick formation of association pathways, giving correct and successful reactions.

Attention. As we continue considering psychological processes, we note that many of them are closely related, that they often are distinguished from other processes with difficulty, and that they influence each other in various ways. Attention, for instance, has much to do with effective learning, for in order to take instructions well it is necessary to be able to keep concentrated on the subject at hand. Modern airplanes are built for high performance, built with more than one engine, variable pitch or constant speed propellers, retractable landing gears, de-icers, radio and numerous instruments pertaining to engine and flight performance. All these apparatus must be attended to by the pilot, and probably in no occupation is it more important to have just the precise development of attention for that particular job than in piloting an airplane.

The desirable type of individual must have this faculty of attention developed to the proper degree—a too highly developed degree of concentration may even make a dangerous flyer. Such an individual becomes so absorbed in concentration on one particular thing until that goal is reached that he is oblivious to everything else. Individuals prone to "absent-mindedness" are usually concentrating so entirely on something else that they can pay no attention to the problem at hand.

On the other extreme is the distractable individual, who seems to lack the capacity to concentrate at all. His attention is so susceptible that it will not remain fixed long enough for him to comprehend the meaning of any of the stimuli he receives so rapidly. Normal span and control of attention is certainly one of the requirements for a flyer.

Emotion. Perhaps there is no vocation in which the emotional factor plays a more important part than in aviation, for when man is flying he is completely out of his element, surrounded by countless dangerous situations, his life and that of his passengers depending upon an emotional stability which will enable him to react at times with lightning-like rapidity. It is well known that resentment, irritation, anxiety, surprise and many other emotional states retard the thought processes and interfere with normal voluntary control over our co-ordinated movements. While under the influence of an emotion, one may make mistakes and errors of judgment which would not have been made under other circumstances. It is even conceivable that one may become "paralyzed" with fear.

The emotionally unstable pilot is apt to carry financial, family or other troubles into the air with him, with the result that he is preoccupied and inattentive. The question of emotional stability is extremely important and flying personnel should have above the average emotional control.

Reaction Time and Age. The regularity and stability of an individual's reaction time are as important in flying as in any other calling where quick decisions and actions are required. The time factor is so all-important in the flying game that those individuals who are even a little slow in their thinking and actions are at a distinct disadvantage. Reaction time may be modified by many causes, such as infectious diseases, fatigue, and other factors. However, aside from such conditions, individuals vary greatly in their speeds of reacting. The question of reaction time has held a prominent place in studies related to the problem of flying for many years.

Youth is a desirable characteristic of the flyer. Reaction time becomes slower as we grow older, though this slowing down process varies in different persons. With increasing age, particularly in postprime years of life, there is a lessened plasticity of the learning faculty. Habits of long duration guide and fix much of one's activity, and new ways and things are assimilated with difficulty. Age should be given a very definite consideration in selecting those who are to fly.

These then are a few of the psychological phases of aviation which we consider in the selection of the individual who is to fly. We should select only those individuals who have a fortunate combination in desirable degrees of the psychological factors we have here discussed, and such individuals will

not be found to be rare. No doubt many hundreds of thousands of ordinary adults are well equipped as potential military flyers, but it should be remembered that there are others, in not insignificant numbers, who for psychological reasons should definitely not fly.

Maintenance. Maintenance of personnel is not a matter which is peculiar to the Air Force; however, in addition to the usual procedures such as hygiene, sanitation, diet, rest and relaxation, which are essential to all, there are certain specific problems which are unique to aviation.

Therefore, in any logical discussion of the subject it will be necessary to mention only briefly some of the problems that we, associated with aviation medicine, are vitally concerned with as having a direct bearing on the maintenance problem:

1. OXYGEN AND HIGH ALTITUDE FLYING

The composition of the atmosphere is uniform below the stratosphere, i.e., approximately 70,000 feet.

	BY VOLUME
Oxygen	21%
Nitrogen	78%
Rare inert gases	1%

As air is compressible, it is denser at lower than at higher levels so that the decrease in pressure on ascent in 1,000 feet is greater near the ground than it is, for example, at 20,000 feet. At 18,000 feet pressure has fallen to half that of the ground level.

Partial pressure in a mixture of a number of gases is that pressure exerted by any one gas within the mixture. It is proportional to the percentage of that gas in the mixture. Oxygen being approximately one-fifth of the atmosphere by volume exerts a partial pressure of 760/5 mm., which equals 152 mm. at ground level.

Oxygen saturation of the hemoglobin of the blood depends on the partial pressure of the oxygen in the lungs. At ground level the partial pressure of oxygen is sufficient to nearly saturate the blood leaving the lungs, so that taking extra oxygen at ground level for short periods, while doing no harm, does no good except in certain instances. Between 15,000 and 18,000 feet the atmospheric pressure has fallen to 428 mm., and the oxygen partial pressure in the lung to approximately 50 mm. of mercury. When the partial pressure of oxygen reaches 50 mm., the hemoglobin can only be approximately 75 per cent saturated, and the tissues are unable to get sufficient oxygen.

Lack of oxygen affects all tissues of the body, and exposure to even slight degrees of anoxia too slight to produce immediate effects will in time impair efficiency and lead to unnecessary discomfort and fatigue.

a. *The Brain. Psychological.*—Defective judgment, spurious self-confidence; lack of self-criticism; inaccuracy; lack of appreciation of time, and the like.

Reasoning.—Alertness dimmed, all mental processes slowed down, later unconsciousness comes on without the individual being aware of anything abnormal.

b. *Vision. By day* the light may appear dimmed and acuity is dimmed.

By night adequate oxygen is of even greater importance because even the slight degree of oxygen lack at 4,500 feet considerably impairs the ability to adapt one's eyes to dim lights and to discern objects dimly illuminated.

e. *Cold.* Lack of oxygen causes the hands and feet to feel cold, and if this occurs, supplying oxygen brings a flood of warmth within a few minutes. However, extra oxygen will not prevent one's feeling cold if one is inadequately dressed.

It should be noted that the above changes, at least in the earlier stages, are not appreciated by the individual himself. Even syncope is such an imperceptible process, that the subject on recovering consciousness may be completely unaware he ever lost it.

Our Air Force now requires oxygen to be used as follows:

a. All flights of 10,000 feet over one hour's duration.
b. All flights to 15,000 feet regardless of duration.
c. From the ground up when the rate of climb is 2,000 feet per minute.
d. Night from ground up.

2. BENDS OR DECOMPRESSION SICKNESS

When air is breathed into the lungs, oxygen alone is absorbed by the blood cells, but by the simple physical laws all gases pass into solution in the fluid plasma of the blood proportionate to their partial pressure. Thus the nitrogen in the plasma is in equilibrium with nitrogen in the air at ground level. During ascent, the pressure of nitrogen in the air, of course, falls and nitrogen comes out of the blood in just the same way that carbon dioxide comes out of a soda syphon when the pressure is reduced by opening the tap. If ascent is slow, the nitrogen has time to diffuse through the lungs. If, however, the ascent is rapid to great heights, the nitrogen comes out of the blood and forms bubbles in the vessels and tissue fluids, causing the tearing of the tissues and blockage of the vessels. This discovery was first made when investigating the caisson disease, or bends, in divers. Divers at 200 feet are exposed to a pressure of six atmospheres, and, while at this depth more nitrogen is absorbed in their body fluids, as rapid ascent takes place they suffer from bends, but slow decompression will completely prevent the illness. A similar condition may develop when ascent is made to 30,000 feet or more at rates of climb attained with the modern aircraft.

3. ACCELERATION OR ACTION OF CENTRIFUGAL FORCE ON PILOTS

Any aircraft flying along any arc of a circle, whether produced by pulling out of a dive, a tight turn, a diving spiral, or any combination of fighter aerobatics, has acting upon it from the center of the circle a centrifugal acceleration which varies directly as the square of the linear velocity and inversely as the radius of the circle. Weight is a force and is expressed as the product of the mass and the acceleration due to gravity or "G." Hence, when a pilot has acting upon him an acceleration of several times that of gravity, his weight increases in the same proportion; and at a centrifugal acceleration of seven times "G" a pilot weighing 180 pounds normally, weighs 1,260 pounds. Every tissue in the body takes part in this increase in weight. At approximately

seven "G" the blood becomes as heavy as melted iron. Consequently, the weight of the hydrostatic columns of blood, which has to remain unaltered in order to maintain the circulation through the brain on the arterial side and the inflow into the heart on the venous side, increases to an extent that cannot adequately be met with by the venous mechanism which returns the blood to the heart from the abdomen and legs and in the capillaries of the abdominal organs and leg muscles where the cross-sectional area is very large. As a consequence of these circulatory changes, there is a fall in the blood pressure in the large vessels supplying the brain and eyes, and, when this reaches a given value for the individual pilot, failure of vision occurs, which we call the "black-out," and if this force continues for an appreciable length of time, unconsciousness will ensue. It has been constantly noted that a succession of "black-outs" without impairment of consciousness is followed by undue feeling of lethargy, lassitude, impairment of mental concentration, or, in other words, extreme fatigue. Average young pilots in good health will take 4½ to 5 "G" for four seconds without a black-out.

4. OCCUPATIONAL FATIGUE

The word "fatigue" here is used to describe: (a) A complex and rather vague clinical condition which is often thought to constitute a definite disease entity, whenever a subjective sense of tiredness predominates. (b) Intracellular or other tissue changes, resulting from overstimulation.

Occupational fatigue has been a subject of paramount interest to physicians interested in industrial medicine and to medical officers in the military services for a great many years. Its presence greatly diminishes both the quantity and quality of the work rendered by the worker in industry, or the military man in one of the armed forces. At no place in the military service is fatigue so likely to occur, and if it does occur, it is not of such importance as in the Air Force.

The term "fatigue," when used in connection with flying, has come to be attached to a syndrome found in flying personnel, particularly those engaged in operational or combat units. Its manifestations are the effects of such work upon the normal individual being submitted to an abnormal amount of stress. Many terms have been used to describe the condition, such as aeroneurosis, flying stress, operational fatigue, staleness and others. I prefer to use the term "flying fatigue" as it seems to me that this is the most descriptive—any change from the normal can thus be associated with the etiology of the conditions.

Nervous breakdown in pilots has been noted since the early days of flying. In military aviation, where the pilot not only must handle airplanes powered with one or more motors of extremely high horse power and be subjected not only to the effects of the resulting vibration, speed, rapid changes in altitude, but also while managing this machine, to the stress of close formation flying and fighting in the air, fatigue makes its appearance much earlier than when flying for pleasure in commercial airplanes. It must also be kept in mind that the lowered efficiency resulting from fatigue in military flying personnel is very likely not only to affect the individual himself, but also to endanger

indirectly the lives of all those who may be associated with him. Many of our military combat planes of today carry crews of from three to ten men. In carrying out a military operation, exact timing and co-operation on the part of every member of the combat crew are necessary, and the results obtained are not likely to be any better than the efficiency reflected by the weakest member of that crew.

The "Flight Surgeon" of the Army is charged with the *selection* and *maintenance* of flying personnel from the physical standpoint. In the selection of applicants for flying training, he attempts to select only those who not only meet the high physical standards necessary for arduous military field service but also only those who possess the necessary psychological qualifications to enable them to complete flying training and to withstand the flying stress or "occupational stress," which will be imposed upon them to a severe degree by combat flying. If proper selection is made, maintenance of the individual will likely not become a difficult problem; however, our biggest problem in maintenance is flying fatigue. The variability of the relative proportions of the subjective and objective symptoms of flying fatigue renders it difficult to diagnose them in the early stages. The trained flight surgeon will be on the lookout for the early and insidious symptoms of this weakness so as to institute prophylactic measures against its full development, with resulting total loss of the individual to combat flying.

PHYSIOLOGY OF FLYING*

Hazards and Remedies

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FLYING is a hazardous undertaking, and it is fitting to discuss here those hazards that are physiological in nature. It has been popular to think of *anoxia* as the chief hazard of high altitude flying. While it is no longer of paramount importance, it still deserves some attention. The man breathing air at sea level is able to saturate his blood almost completely with oxygen. The range of saturation is remarkably narrow, usually being within the limits of 94 to 96 per cent. This results in a partial pressure of oxygen in arterial blood of about 80 mm. Hg. Man has become accustomed to that condition; the tissues of the body have been organized on the basis of that partial pressure of oxygen in blood coming to them. The one organ most sensitive and which suffers greatest from reduction is the brain. This hazard of oxygen lack arises between 10,000 and 20,000 feet where the pilot is not using his oxygen supply. As he goes higher, using his oxygen supply, even assuming it is functioning perfectly, when he reaches an altitude of about 37,000 feet, he again begins to become

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anoxic. The reason is commonly overlooked by medical students and physiologists who do not appreciate the fact as the total pressure decreases a point is reached at which even with pure oxygen the blood is not saturated. This critical altitude is around 37,000 feet, and breathing oxygen at 40,000 feet is roughly equivalent to breathing air at 10,000 feet. The limit of consciousness breathing pure oxygen is near 45,000 feet.

Another hazard and one much less well understood is *aeroembolism*. It depends not upon oxygen supply but upon the absolute pressure. At 18,000 feet the pressure on the body is just half an atmosphere, and at 40,000 feet it is one-fifth of an atmosphere. As a result, nitrogen tends to be released from solution in body fluids. As we sit quietly at sea level we have in our lungs a partial pressure of nitrogen of something over 550 mm. That gas in the lungs must necessarily be in equilibrium with the blood passing through the lungs, and the solubility of nitrogen in the blood is such that about 1.4 volumes per cent of gaseous nitrogen is dissolved in it. Every liter of the blood will contain about 14 c.c., and that is also true of the water in the rest of the body. A larger proportion dissolves in body fat. The analogy has been drawn between the state of this gaseous nitrogen in the body fluids and the state of carbon dioxide in a bottle of soda water. In either case, when the pressure is suddenly decreased, gas bubbles form.

There are a number of curious facts about aeroembolism that we do not understand. We know that at 18,000 feet the pressure on the body is reduced one-half, and yet no one ever experiences any trouble from aeroembolism here, nor even at 25,000 feet. At 30,000 feet very few people will experience symptoms during the first hour of exposure. At 35,000 feet no one is likely to suffer during the first few minutes.

The best guess as to the explanation of these facts is that while the nitrogen escapes from solution at once, the first bubbles formed are too small to cause trouble. In time they increase in size by coalescing with adjoining bubbles by the diffusion into them of carbon dioxide and water vapor oxygen.

A third hazard is that of *acceleration*. We know that a man may faint on a hot day while standing at attention, i.e., when exposed to 1 "G." When we consider that a man in an aircraft is not uncommonly exposed to three times that force and for short times to five or six times that acceleration of gravity, we can readily imagine that fainting is very likely to occur. In a pull-out from a dive, the "G" is often as great as 5 for a period of a few seconds. If the man is sitting erect, venous return from below the heart will be stopped, and the arterial supply above the heart, and in particular to the brain, will be handicapped. Within a short time the heart is inadequately filled. There will be but a small amount of blood discharged with each beat, and the tendency will be for blood that does leave the heart to go down rather than up. Most of our knowledge of the physiology of acceleration has come from Germany, where a centrifuge has been in use for some years. There are many important questions awaiting solution, such as the possibility of selecting men who are resistant to acceleration, of determining the factors that make him either more or less resistant to acceleration, and of training men in the techniques of resisting acceleration.

A fourth hazard of flying is *cold*. This needs no special emphasis here, because the hazard of cold in high altitude flying is little different from that experienced by the man on the ground in cold climates. One point requires special mention—the relation of shivering to the problem of oxygen supply. In the present oxygen-supply systems it is assumed that the man is not going to use very much oxygen. However, if the man gets very cold and starts shivering, his oxygen consumption then may go up to two to five times, and then two hazards may be superimposed, anoxia developing if his oxygen system is inadequate for this emergency.

Vibration can be put down as a fifth hazard. This properly includes noise. Some individuals are extremely resistant to noises. Others are rather sensitive, and it is safe to assume that the exhaustion experienced in flights of many hours' duration depends in no small degree on this hazard. In a project at Harvard designed to study physiological effects of noise, physicists have been able to reproduce the characteristics of the noise of an airplane propeller with extraordinary fidelity.

A sixth hazard which cannot be separated from these others is *fear or anxiety*. It arises from being in a strange environment, from being uncertain whether he is going to reach his field or whether, when he gets back, he will be able to land. If we add to the hazards already mentioned the emotional experience of combat, it is quite clear that the combined effect is a serious strain on the organism, a strain that can be tolerated once or twice or a few times but cannot be tolerated too often; there must be opportunities for recuperation.

Having presented some of the facts about the hazards of high altitude flight, I am going to return now to a more detailed discussion of some of them, beginning with anoxia. There is, first of all, an adaptive response to anoxia that is believed to depend on stimuli arising in the carotid body. Respiratory volume is increased, thus preventing such a reduction in arterial oxygen as would otherwise occur. The extent to which respiratory volume can increase in extreme anoxia has been demonstrated by Dr. Corwin and Mr. Horvath here at the Metropolitan State Hospital last summer. The respiratory volume reached 25 to 30 liters per minute merely from the stimulus of oxygen lack. The same patients, if poisoned with carbon monoxide, would become unconscious without any increase of respiratory volume.

What are the effects of oxygen lack on the muscular system? We know that a single contraction of a muscle can be carried on equally well whether oxygen is present or not. It can be shown that a man at an altitude of 20,000 feet has as great strength as under ordinary conditions. However, if he attempts to continue, there will be a breakdown, because recovery processes are handicapped by oxygen lack.

In the nervous system the story is different. The functioning of the nervous system depends upon a virtually continuous supply of oxygen and almost immediately, when a given stage of anoxia is established, the various mental functions show decreased efficiency. Sleepiness, for example, is one of the common effects of anoxia. A man exposed to moderate anoxia may sleep for hours at a time. With prolonged and more severe exposure, the sleepiness may verge on unconsciousness. Stupor is not uncommon. The phenomenon of persevera-

tion is commonly seen. We have sometimes asked anoxia subjects to write a sentence that includes the phrase "around the rugged rock." It is a common error, when they get to this expression "around the rugged rock," a phrase which in itself suggests repetition, to write repeatedly "around the rugged rock."

If anoxia is prolonged, more unpleasant effects, such as nausea, headache, and vomiting, may occur. The headache may become most severe after the period of exposure, as is also true in carbon monoxide poisoning.

An instructive illustration of both the direct and indirect effects of failure of oxygen supply may be given. The test subject was riding a bicycle in the chamber at 40,000 feet. We had him hooked up to a cardiotachometer, and I was getting ready to make an arterial puncture on the man while riding the bicycle in order to determine the adequacy of his oxygen equipment. I picked up the needle and syringe and started to put a sponge in a dish of alcohol. This dish instead of having the usual dye-colored fluid had a clear solution. I wasn't sure it was alcohol and I took off my oxygen mask momentarily to sniff it. A few seconds later I again took off my mask to announce over the teletalk that I was going to make the puncture. Then I walked around, facing the subject, but as I got into position with the syringe in one hand and the sponge in the other, I slowly settled to the floor and leaned my head back against the wall of the chamber. This, for the first few seconds, did not seriously alarm the man on the bicycle. He thought it was a peculiar thing to do, but in about ten seconds he fully appreciated that I had passed out, and also that there wasn't anything he could do about it. He was hooked up to an oxygen system that didn't permit him to get within reach of me. There was an observer on the other side, who signaled to the chamber operator outside, and within two minutes we were down to ground level. The most interesting observation made in that case was on the man riding the bicycle. His pulse rate was 110 before my collapse; it rose to 120 when he first saw me acting curiously, and then it went to 185 during the next ten seconds, when he appreciated that I had passed out. The lesson from this is that in a plane where you are at a higher emotional pitch than is likely to be reached in a chamber, an accident to one man is certain to have a very powerful effect on some of the other men. That is the time when serious mistakes are likely to be made, leading possibly to disaster.

Such an incident illustrates the sort of experiences that one faces in the air, and I want to emphasize once more that in studying the problems of high-altitude flight, you should divorce from your mind the deep-seated idea that they can all be answered by putting mice in a cage and subjecting them to low oxygen.

Returning now to the subject of aeroembolism, I wish to say a little about protection against it. Since it is produced by the formation and growth of nitrogen bubbles, it would appear reasonable to try eliminating some of this nitrogen before starting a flight. The most effective means consists in breathing pure oxygen during exercise, the nitrogen, of course, being gradually evolved by the lungs. Exercise that raises the metabolism to four times the

resting level, involving a respiratory volume of twenty liters a minute and an increased circulation rate, will result in the release of at least half the nitrogen of the body within a half hour. The man is then able to undergo a greater reduction in pressure or to stand a very much longer exposure to a given altitude than would ordinarily be the case. This procedure is likely to have usefulness in some missions. It obviously cannot be used in defense warfare, because a man on defense has to be ready on a minute's notice. It seems that it could be made practical in offensive operations or whenever missions are planned ahead of time.

The obvious method of protecting against the anoxia and cold, as well as the aeroembolism of extreme heights, is the pressure cabin. You have heard of the commercial plane that maintains a small positive pressure in the cabin so that when it is 20,000 feet, the effective pressure inside is equivalent to 10,000 or 12,000 feet. There is considerable advantage in this. The military pressure cabinet is still on the blueprint stage so far as I know. On paper at least, it is possible to make a cabin that at 40,000 feet will maintain a pressure within equivalent to 10,000 or 12,000 feet. Compression of that air will heat it enough to keep it comfortable.

Something should be said about *visual function* of pilots. A subject about which I presume you have heard much within recent years is night blindness. There was a great furor about two years ago, and one of the first published papers in this field indicated that vitamin A deficiency was rather common. Many measurements have been made during the last year in military personnel, and practically speaking, you never find a case of poor night vision improved by vitamin administration. However, these studies have been useful in revealing a wide variation among healthy men, a variation that appears to be inherited; at any rate, it is relatively constant in a given man. It remains to determine the practicability of selecting men with exceptional night vision for night flying.

SOME PROBLEMS IN AVIATION MEDICINE*

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AVIATION medicine is a newcomer among the medical specialties. It was born during the First World War, when the lack of fitness among airplane pilots became strikingly apparent. Some idea of the urgency of the problem at that time can be gained from the fact that in the British forces 90 per cent of the plane casualties during the first part of the war were due to pilot error, and only about 2 per cent of the plane casualties were due to enemy action.

Steps were immediately taken to improve upon the method of selection of pilots and to do a better job in the maintenance of their health and fitness. Certain criteria were laid down which served as a yardstick for selection. For the most part, they dealt with the physical criteria for selection, and the value of the standards laid down at that time is attested by the fact that they have not been materially altered since.

Following the First World War, aviation medicine received a setback, and interest was not revived until the great development of commercial aviation, which began in the late twenties. At that time various studies were made, not only with regard to the care and selection of pilots, but also with regard to the comfort and safety of passengers. Now the major interest has again shifted back to military aviation, with the onset of the Second World War. At the present time, there are many and important problems requiring solution, and this condition has come about so abruptly that there is a great lack of trained personnel in this field.

Many people at this time are under the impression that the modern airplane has reached such a state of perfection that the pilot's work has, therefore, become much easier and simplified. Actually almost the reverse of this is true. The airplane, as Dr. Hunsaker of the Massachusetts Institute of Technology points out, is still subject to the laws of gravity, will still slip and fall into a spin, and still presents many of the "old difficulties" in flight. With every increase in the reliability of the airplane, there has also been an increase in expectancy of performance. Increasing the speed of the plane and the height to which it may ascend has served to introduce such problems as aeroembolism, anoxia, and the black-out. None of these problems were of any great significance during the First World War, but are of first importance at this time.

THE SELECTION OF PILOTS

Someone has said that out of about thirty-odd billion people born in the world, only about five thousand ever amounted to much, and that is somewhat the way it is with the selection of pilots. Out of a large number of apparently

*Lecture XXII, reprinted from *Collected Lectures* of the Metropolitan State Hospital, Waltham, Mass., 1942.

healthy individuals, only a small number are really fitted, both physically and psychologically, to pilot an airplane. Armstrong has stated that if a man is examined and is found to have no obvious physical defects and is satisfactory for any ordinary type of occupation, he still could have a hundred defects which might disqualify him from becoming a good pilot. In addition to the physical defects there are, of course, the psychological aspects to be considered, and the pilot's aptitude for flying.

Some idea of how few are fully qualified for military pilots is gained from a study of the pilot selection at one of the training stations. The majority are selected from the students in nearby universities, although a number apply from all over the United States. First of all, these college students are sent a questionnaire, which they fill out; if certain basic educational and physical requirements are met with, they are given the physical examination. This examination is quite thorough. It not only includes the usual physical examination but also includes a careful examination of the special senses and a "short-arm" psychological examination. As a result of this procedure in a typical sample of 753 candidates, only 42 per cent were accepted as representing sufficiently good material to start training. Thus, in an already select group of individuals, about 60 per cent were immediately disqualified. Of those that are finally selected as student pilots, somewhere between 25 per cent and 40 per cent are eliminated during the first six months of training. This represents, of course, not only a large economic loss, but, what is more important in wartime, a serious loss of time and effort.

A chief problem then is to devise some system of selection whereby only those who are likely to succeed will be permitted to enter training. The problem has been attacked in various ways. For example, the physiological and psychological characteristics of successful pilots have been analyzed in an effort to obtain criteria for selection. Another method has been to carry out various examination procedures and tests on all the incoming pilots and then see if those failing and those succeeding make different scores on the various tests. It is not to be hoped that any single test will separate the good from the bad material, but it is hoped that some day a battery of tests will be discovered which will greatly aid at least in the selection process.

Much time and care are now given to the maintenance of health and physical fitness in pilots. Periodic examinations now are required in order to insure that certain physical requirements are being met. In commercial aviation a limit of eighty-five hours a month has been set as the maximum flying allowed. Gradually, there has come about an increasingly close relationship between the pilot and the flight surgeon, with the common objective of keeping the pilot flying as long as possible.

OXYGEN LACK

One of the most important problems in aviation medicine results from the progressive decrease in oxygen pressure with increasing elevation. Every physiological function depends upon the supply of oxygen, and when this is reduced, the function must be restricted accordingly. The extent to which the body is affected depends not only on the altitude reached but also on

the rate of ascent and the length of time aloft. Certain physiological characteristics of the individual are important as is the state of health. As Dr. Dill has pointed out, the aviator or airplane passenger makes certain adjustments as the result of reaching a high altitude, but, unlike the mountaineer, he undergoes little or no acclimatization even though oft-repeated flights are made.

Commercial airplanes for the most part fly at altitudes below 10,000 feet but in certain regions they fly at altitudes of 14,000 to 15,000 feet and may on occasion go even higher. A recent Civil Air Regulation requires the crew to use additional oxygen if flying above 12,000 feet or if flying above 10,000 feet for thirty minutes or longer. Nearly all the commercial planes which fly at altitudes over 10,000 feet contain equipment for oxygen administration to passengers. In military aviation most of the flying is still done at relatively low altitudes, but some is done at elevations between 35,000 and 40,000 feet. At 40,000 feet the alveolar oxygen tension of a pilot inhaling pure oxygen corresponds to that of a pilot breathing air at 11,000 feet. From a practical standpoint it is nearly impossible to prevent slight leakage when using an oxygen mask, so that the degree of anoxemia usually exceeds the theoretically calculated amount.

Very briefly I will discuss some of the effects of oxygen lack, particularly on the nervous and circulatory systems.

If anoxia is rapidly produced, as in an actual or simulated ascent in an airplane, the first and most important effects are seen in relation to the central nervous system. Psychological impairment to a slight degree may be observed below 10,000 feet but it becomes more definite at higher elevations. At first there may be a feeling of well-being and even euphoria. A false sense of enhanced powers is often experienced, which is in many respects similar to mild alcoholic intoxication. This state gradually passes into one of mental dullness at elevations around 14,000 to 15,000 feet, and some persons become sleepy. At this stage of decreased sensory acuity vague feelings of uneasiness and bodily discomforts tend to disappear, the anoxia acting somewhat as an analgesic. At higher elevations the signs and symptoms of anoxia become progressively more marked, and fainting or unconsciousness occurs. Few, if any, unacclimatized persons remain conscious at elevations in the neighborhood of 25,000 feet.

The obvious treatment for symptoms of anoxia, or better yet, their prevention, rests in supplying an additional amount of oxygen. The most practical method of giving additional oxygen is by means of a mask fitted over the nose and mouth. This procedure is quite satisfactory for elevations up to 35,000 feet or a little higher, but above that level the partial pressures of water vapor and carbon dioxide in the alveoli form too large a part of the total pressure and even breathing 100 per cent oxygen is insufficient. It then becomes necessary to supply oxygen under pressure as in a supercharged cabin plane.

My own interest in aviation medicine is concerned chiefly with problems relating to the cardiovascular system. In considering this problem, it is essential to distinguish between the direct effects of oxygen lack on the heart and the effects on the peripheral circulation both in the healthy person and in the patient with heart disease.

With regard to the heart itself there is much evidence that a person with a normal or even a diseased heart may withstand surprisingly severe degrees of oxygen lack without evidencing heart failure.

Healthy subjects during high altitude flight or those exposed to low oxygen tensions in the laboratory rarely complain of symptoms directly referable to the heart.

The dyspnea which may be noticed is not severe and is due to stimulation of the peripheral chemoreceptors by anoxemia and is not a sign of heart failure. Pain of cardiac origin is never noticed and palpitation very rarely. The fatigue which commonly appears during long flights, and the state of easy fatigability which follows, is probably related to the effect of anoxia on the central nervous system.

Of all the circulatory changes due to diminished oxygen tension, acceleration of the heart rate has been studied the most. With successive decreases in oxygen tension the rate continues to increase slowly, but the increase in rate is not marked until extreme degrees of anoxemia are reached. Sometimes there is little change in the heart rate or actual slowing and bradycardia may be associated with the collapse.

The changes in blood pressure due to increasing anoxia follow several fairly well-recognized patterns. In the majority of healthy persons there is little change until the oxygen in the inspired air has fallen to low levels. Then there may occur a gradual rise in systolic and a fall in diastolic pressure, with consequent increase in pulse pressure. In susceptible persons exposed to moderate degrees of oxygen deficiency, fainting may occur and there is a sudden fall in both systolic and diastolic pressure. This fainting reaction is in the nature of peripheral vascular collapse and is caused by cerebral anoxemia and is not due to heart failure. In a few subjects there is little change in blood pressure until unconsciousness supervenes. It is only at this stage of crisis that the fall in blood pressure may be directly attributable to a failing heart.

The cardiac output increases in healthy persons at rest under conditions of moderate anoxia. This increase may be regarded as a compensatory or adjustment mechanism. With marked decreases in oxygen tension the cardiac output may fall as a direct result of cardiac anoxia, but this stage is never reached under present flight conditions. More studies along this line are necessary before the relationship between anoxia and cardiac output is properly understood.

There are many reports, especially in the older medical literature, describing cardiac dilatation or hypertrophy in mountaineers or in those resident at high altitudes. There are also a few published observations purporting to show that cardiac enlargement may occur in aviators or in subjects exposed to reduced barometric pressures. Etienne and Lamy observed slight to moderate cardiac hypertrophy in ten of the eleven aviators of a celebrated escadrille. They considered that this hypertrophy developed in two stages and invariably involved the left ventricle. In the first stage, which lasts only a few months, the heart increases in size relatively rapidly, and this is followed by a second stage lasting two to three years, in which the hypertrophy is slowly progressive.

Whitney observed dilatation (by percussion) of the heart in five of ten healthy subjects as a result of a reduction of barometric pressure simulating an altitude of between 14,000 and 20,000 feet. Increases in transverse diameter of from 3 to 5 cm. were said to occur. Le Wald and Turrell, on the other hand, in a carefully controlled roentgenological study of 89 aviators under conditions simulating high altitude, observed a decrease in size of the heart in 14, no enlargement in 66, and an apparent enlargement in 9. In 6 of these 9 the increase in size was explained by alterations in the position of the diaphragm while in the remaining 3 the transverse enlargement was only 0.4 cm. or less. It is now quite generally agreed that the normal heart, if the subject is at rest, does not dilate even with greatly lowered oxygen tensions. This conclusion is borne out by animal studies in which it is shown that cardiac dilatation does not begin until the oxygen saturation has fallen to about 50 per cent or below.

The electrocardiographic changes have been studied during actual flight conditions as well as under conditions simulating high altitudes in the laboratory. In healthy persons these changes consist of progressive lowering of the S-T segments and T waves with increasing anoxia. Occasionally, the T waves may be diphasic or even slightly inverted. Some of the most marked electrocardiographic changes observed in healthy subjects were obtained by Dr. Corwin and Mr. Horvath in experiments on acute anoxia conducted in this hospital. Especially marked was the lowering of the S-T segments and T waves.

That alteration in the carbon dioxide tension alone may cause electrocardiographic changes has been described by Barker and others, and we have confirmed these observations as to the lowering of the T waves and slight downward displacement of the S-T segments following overventilation for three minutes. That overventilation may be a factor in producing the electrocardiographic changes observed at high altitudes is highly probable.

Thus, in normal persons the symptoms which may appear under conditions of civil or military aviation and the changes in circulatory dynamics do not indicate heart failure but may be considered in the nature of adjustments or compensatory reactions to the oxygen deficiency; the most trustworthy evidence we have supports the view that the normal heart is not damaged. With respect to peripheral circulatory collapse this may occur in susceptible individuals even at relatively low altitudes and is due primarily to the effect of lack of oxygen on the central nervous system.

DECOMPRESSION ILLNESS

Decompression illness is another hazard which must be considered. When the atmospheric pressure is suddenly decreased, such as occurs during rapid ascents to high altitudes, symptoms arise as a result of the formation of gas bubbles in the body tissue and fluids. This bubble formation takes place in accordance with the laws governing the solubility of gases. Blood passing through the lungs is exposed to the gases in the atmosphere, and each gas is absorbed according to its partial pressure. Relatively large amounts of nitrogen go into solution because of its high partial pressure, while oxygen and carbon dioxide are taken off in smaller amounts. The body has special transport systems for oxygen and carbon dioxide but not for nitrogen, which is relatively inert and obeys the laws of simple solution. Now, if the atmospheric pressure

is decreased, the body tissues and fluids tend to give up the dissolved gases, principally nitrogen, by way of the lungs. If the decrease is sudden and of the order of half an atmosphere or more so that the concentration of nitrogen is at least double what it should be, this gas will come out of solution and form bubbles to which is added some oxygen, carbon dioxide, and water vapor from the surrounding blood and tissues. There is considerable difference in opinion regarding the height of ascent before clinical symptoms appear. Armstrong states that gas bubbles are found in the spinal fluid at 18,000 feet while bubbles in the blood and tissues generally have not been found below 30,000 feet. He believes symptoms are rarely noted below 30,000 to 35,000 feet. However, English observers are of the opinion that symptoms may appear at lower altitudes than these. The most dangerous symptoms occur, of course, when bubbles appear in the blood stream. Aeroembolism of a cerebral artery may lead to severe central nervous system disturbance while if the coronary arteries are involved, heart failure may result. This, then, becomes an important problem, especially in military aviation. Dr. Dill, in the previous lecture, has told you of his striking experiences with aeroembolism.

ACCELERATION

Another adverse influence on the cardiovascular system is that of centrifugal forces (due to positive accelerations amounting to as much as nine times the force of gravity) which may be encountered during the combat maneuvers of modern fighter aircraft. The effects of positive accelerations when these are in the longitudinal axis of the body are observed most dramatically in the displacement of blood from the upper to the lower portions of the body. Forces greater than 4 to 5 "G" acting for three seconds cannot be sustained without symptoms. If the force acts only for a short time, the blood supply to the eyes and then the brain becomes deficient, and the vision becomes dimmed or lost. If the centrifugal forces act sufficiently long, the venous return to the heart becomes inadequate and complete circulatory collapse ensues. Dr. Dill, in the previous lecture, has described the underlying physiological changes and the symptoms produced.

AIRPLANE SICKNESS

Sickness in an airplane is usually due to the movements of the plane or oxygen lack, or a combination of both. Sometimes the former is referred to as airsickness and the latter as altitude sickness, but as both conditions may be present at the same time, a term such as plane-sickness is useful.

Airsickness is akin to seasickness both in etiology and symptomatology. The up and down movements of the plane are the chief immediate cause, but many other factors such as fear, fatigue, alcoholism, etc., play an important role. Persons who develop airsickness readily do not make successful pilots, but on occasion even a pilot of long experience becomes sick.

Nausea and vomiting may be caused by oxygen lack and may be a distressing part of acute altitude sickness. Pilots will often fly higher than usual in order to find less turbulent air. Often a compromise must be worked out between "rough" air and adequate oxygen and "smooth" air and deficient

oxygen. The story is told of a South American pilot who was informed by the steward that only eight box lunches had been put aboard for fourteen passengers. He said, "Don't worry, I will get you out of that fix," and began to ascend to a higher altitude. In a short time so many of the passengers had lost all notion of eating that there was a surplus of box lunches.

EARACHE

Changes in atmospheric pressure naturally affect any gas-filled cavity which is closed. Of chief importance in this regard is the middle ear. Normally, the Eustachian canal is only a potential tube, and it may be necessary to chew gum, yawn, and manipulate the tissues anterior to the head of the mandible in order to open the tube temporarily. If there is swelling due to a cold, the individual may suffer acutely, and sometimes it has been necessary to delay a landing because of this.

CONCLUSION

In conclusion it may be emphasized that many problems pertaining to aviation medicine await solution. Only a few have been mentioned here and notable omissions include pilot fatigue, cold, glare, vibration, etc., and the many problems of medical organization.

PHYSIOLOGY OF FATIGUE*

Factors and Criteria of Endurance

Lieut. Col. D. Bruce Dill, Dayton, Ohio

THE subject that I am going to discuss first is the dependence of fatigue on stresses. It is well-known to all of you in your experience as medical students that fatigue is a phenomenon that can be studied in an isolated muscle. The muscle can be given a task to do which at first it is able to do, and for some time, minutes or longer, it will continue to do at a rate which is maintained constant. Eventually a time will come when the work out of that isolated muscle will begin to fall off. That very simple conception of fatigue is applicable in some respects to all forms of fatigue, whether it is physical or mental. We say that fatigue is a state in which the organism has lost its capacity to carry on. It has a limited capacity for work. In the isolated muscle we can tell pretty well what some of these changes are. If the work has been carried on, for example, in an atmosphere of nitrogen, chemical changes can be detected by analysis which depend on the use of the energy reserves of that particular system anaerobically. If the system has been in an atmosphere of oxygen, work will be carried on longer, and the nature of

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the breakdown will be different. In the intact organism the picture is more complicated, but we can produce a state in the sprinter, for example, similar to the state seen in the isolated muscle. The sprinter is called upon to transform an enormous quantity of energy within a very short time. He has supplied nearly all of the energy from certain reserves that can be used without oxygen. When the work is done, there is a period of recovery in which extra oxygen is used, and eventually the original state of the organism is restored.

Another type of breakdown is one in which there is less heavy stress, but one of much longer duration. To give an illustration we enter another field of sport, that of the marathon race. In this we see a man working at high capacity for two and one-half or three hours. The chemical picture in this case is a very different one. The quantity of anaerobic energy available to a marathon runner is not of any significance. Since his energy expenditure is distributed over a period of two and one-half or three hours, he must rely upon oxidative processes. If we draw blood from a marathon runner when he has finished the race and compare its composition with that drawn from the man who has finished a sprint, we get important clues to the processes which have gone on within the muscle in the two cases. In the sprint we may find a blood sugar concentration of 150 or 200 mg. per cent. We may find a lactic acid concentration of 150 mg. per cent, which is to say fifteen times the normal resting level. The high blood sugar concentration in the sprinter may be interpreted as meaning that he has a copious supply of available carbohydrate. Because of the physical exertion plus the emotional factors involved, his reserve of carbohydrate has been mobilized and made available for this strenuous exertion.

In the marathon runner at the end of his race we may find blood sugar concentrations in occasional instances as low as 50 or 60 mg. per cent and lactic acid concentrations of 15 or 20 mg. per cent. However much the emotional situation may have raised the blood sugar in the beginning, by the time the race is over the carbohydrate reserves are depleted, blood sugar is apt to be at a low level, and the fuel is almost exclusively fat. The fact that his lactic acid concentration is low is evidence that he has not been expending energy anaerobically; oxygen has been supplied as fast as the fuels require it. These two contrasting conditions, the one depending largely upon anaerobic work, the other depending exclusively on aerobic work, represent two types of stresses placed upon the organism. The first is a very intense stress of short duration; the second, a less intense stress of longer duration.

The third type of stress to which attention must be paid is that of moderate degrees of exertion carried on for a very much longer time. We can give as an illustration of that the present-day laborer in heavy industries, for example, who still has hard work to do and who today may be working overtime—ten hours a day instead of seven. His fatigue is more like that of the marathon runner than it is like that of the sprinter; however, the biochemist cannot tell us very much about the fatigue of this laborer who may work ten or twelve hours a day. We know this man experiences fatigue, but it is composite in nature, made up in part of physical factors and in part of psychological, or if you wish, mental factors.

In that connection, I think it is worth while to refer here to the experience in England during the last year with overtime labor. This subject was studied very thoroughly in England during the last war, and the conclusion was reached that beyond some reasonable limit, nothing was gained by lengthening the work week. However, history repeats itself, and a year ago at the time of the collapse of the French, the British workman was called upon to give up his holiday weekend, to give up his leave, and to put in extra hours, mounting up to seventy or eighty hours a week. For a few weeks the output increased, and then it began falling off, and before long the weekly output had decreased. An inquiry was made by officials appointed to consider this particular question. They reached a number of significant conclusions; one of the most important is that under their conditions the most effective work week did not exceed fifty-five or fifty-six hours. They analyzed many individual instances of failure to maintain weekly output. After men had been tired out by these long hours, they decided they must have a day off. Instead of Sunday, when they received extra pay, they would take Wednesday. Among those who tried to put in these long work weeks there were more illnesses, increased loss of time because of accidents, and a general breakdown of morale. After this survey had been made, it was recommended that the work week should not exceed fifty-five or fifty-six hours. This experience has a practical lesson for America, because increasing pressure is being put on workmen for greater output. They are being encouraged to give up their vacations, and I understand that many workmen in this country are, at present, putting in seventy or eighty hours a week. This is a very shortsighted policy bound to fail of its purpose in the long run.

Another type of stress involves very little in the way of physical effort but does involve mental or emotional stress of various sorts. I am not qualified to discuss this here; it is a field in which you are experts and I am not, but I again want to give you a simple illustration, and perhaps at the end some of you will wish to make some comment on it. It is not only workmen who are called on to put in overtime; executives are doing so habitually. I think this is a mistake, whether in private business, among civil servants, or in military circles. The idea that a man can work at his desk for eight hours a day, go home and work another four hours at night is fundamentally unsound. It produces a fatigue that results in decreased output. Such an executive is likely to find himself going through the motions without thought or considerate action. I am going to risk saying that a good many of our difficulties today arise from the fact that the men at the top are too busy to think.

The second question which I wish to discuss is the dependence of fatigue on endurance. No matter what training is given a group of candidates for a track team, some will turn out to be superior and some inferior. In other words, one aspect of the dependence of fatigue on endurance is the native endowment. Whether we speak of the purely physical endowment or of mental characteristics, there are inherent differences which must be taken into account. Differences in native endowment are important in the selection of pilots as those of you who are medical officers well know. The same is true for selection of men in any walk of life. Our sprinter is a man with a very unusual

endowment; unusual mental powers are not required, but he does have legs of a particular type, a heart of unusual capacity, and a will to "put out." In prolonged physical effort a different type of endowment is required. The sprinter is likely to be a short man with heavy legs, whereas the successful marathon runner is commonly thin and wiry. We have made some tests of the capacity of various types of athletes in the Fatigue Laboratory. The one striking characteristic of the highly successful distance runner is his very great capacity for supplying oxygen to his body. The most notable example is Don Lash, the two-mile record holder of a few years back. He weighs 140 pounds or something of that sort. In a laboratory test we found that he could supply 5.35 liters of oxygen per minute. Most of us here cannot supply much more than one-half that much. That characteristic depends first on the capacity of the lungs to absorb the oxygen, of the heart to circulate the necessarily large quantity of blood required, and finally, a distribution of capillaries in tissues that favors the rapid delivery of as much oxygen to the cells that are doing the work.

The executive who can do this job of working twelve hours a day without breaking down must have very unusual mental endowment. He is a man who is able to take these continued stresses and bear up under them. He is able to consider one question at a time, settle it, drop it from his mind, and take up another. I say again that I am not qualified to discuss fatigue of this sort, but it intrigues me a great deal.

The other point important to this subject, i.e., to the dependence of fatigue on endurance, is, of course, the role of training. I said that any group of candidates for a track team could be trained indefinitely and great differences in performances would persist. However, all of these men are going to improve, and it is a very interesting physiological problem to determine the nature of this improvement. Why is it that a man can report for track team at the beginning of the year able to run a mile in five and one-half minutes and after three months' training become able to run one mile in four and three-fourths minutes? That improvement in the course of three months is not impossible. We have made a good deal of study of that development and know a good deal now as to just what happens in such an individual. In the first place, the improvement is, to a considerable extent, dependent upon skill or coordination. The man at the beginning is not merely covering a linear distance of one mile, but at every stride he is raising his body much more than is necessary. With every lift of his body a certain amount of energy must be expended. If you study moving picture records of the skilled runner as compared with the unskilled runner, you will see that the skilled runner goes along with only a slight undulation of his body; a large portion of his energy expenditure pushes his body forward.

There is also the development of conditioned reflexes. The coach at the beginning emphasizes time after time the proper methods of running. At first the runner takes thought for every stride, but eventually after he has done this for weeks or months he is able to run without giving thought to these aspects of his job, and then he has time available to consider the other aspects of running, to pay some attention to his competitors, and to judge the timing of his race.

That simple illustration applies to every walk of life. We have seen, for example, steel mill workers carrying out operations with ease that are simply impossible of attainment by the inexperienced man. That is possible because they have learned to do the job the easy way; they have acquired conditioned reflexes such that without giving thought to their job they can carry it through. That has great advantages in industrial jobs other than the mere conservation of physical energy. It means that the man who has learned his job well enough to carry it through without much thought has his mind free for reveries.

No doubt part of the role of physical training is the increase of muscle mass. The blacksmith has the large and powerful arm; it has become so in part because of the training it has had. No doubt muscles increase in size and strength with continued use; they hypertrophy if you wish to use that word. We have heard of the hypertrophy of the heart due to hard muscular effort over a long period of time. As far as I know, cardiologists have found nothing necessarily abnormal about large hearts in athletes.

In a man undergoing strenuous training there may be an increase in capacity for utilizing energy aerobically. A man before he has become trained may utilize three liters of oxygen a minute, and maybe 3.5 liters a minute after strenuous training. With prolonged and very strenuous training, it can be increased more than that. There may also be, as reported by Robinson and Harmon of the University of Indiana, an increased capacity for anaerobic utilization of energy. The highly trained man can push his blood lactate to twice as high a level as is attained by the untrained individual. That is an indication the anaerobic utilization of energy can be developed by long strenuous training.

The third topic I wish to discuss is the question of tests of physical fitness and the criteria of physical fitness. Unfortunately, there isn't any adequate, simple test of physical fitness. As physicians you all employ some simple test of physical fitness. You have your patients walk up and down stairs or step up on a chair or something of that sort, and you get some sort of idea as to their physical fitness. Some of you are familiar with Schneider's test. While useful for some purposes, this apparently doesn't give a reliable index to physical fitness. It is still used by flight surgeons, and it is believed to be useful in judging neurocirculatory stability. A reliable measure of physical fitness must put the whole body under a stress, calling for maximum effort, not merely by a small group of skeletal muscles but by the heart itself. Enough skeletal muscles must be put in use to approach the capacity of your cardiovascular system.

In one such test developed at the Fatigue Laboratory, the man first walks on a motor-driven treadmill at about 3½ miles an hour and on a 9 per cent grade. This is continued for about ten minutes, while we collect expired air, determine his oxygen consumption, measure his heart rate, make various blood tests, etc. This serves as a warming up period for the later test. After a few minutes' rest we speed up the treadmill to 7 miles per hour and have him run for five minutes or for a shorter time if that is impossible. In this test a measure of capacity of the individual to supply oxygen to his tissues is obtained;

this, to our minds, gives the most precise index of the over-all fitness of the cardiovascular system, and for that matter of the whole body as a machine. That figure, the maximum intake of oxygen, shows a wide variation among individuals, depending upon the original physical endowment, the training which a man has had, and the age of the individual. He reaches his maximum around the age of 20 to 25, and thereafter declines, perhaps as much as 50 per cent by the time he is 70. This sort of test is like that the engineer makes if he is called upon to compare the performance of two engines. He doesn't merely measure energy output and gas consumption while the engines are idling.

Some such test, if simplified, may have practical applications. We know that the Germans segregate unusually qualified individuals; very extensive psychological and neurological tests are made of men to find men of unusual mental capacities, and we know that they have troops sorted out on the basis of physical endowments. Storm troops were organized in the last war, and they are certainly playing a role in the present war. How can you select such men? That is a subject to which much thought has been given at the Fatigue Laboratory, Harvard University, during recent months. The "Pack Test," developed there and widely applied in both civilian and military circles, appears to give the most reliable index to physical fitness. Men who pass this test successfully not only are good athletes, they are tough fighters.

THE INFLUENCE OF AMPHETAMINE (BENZEDRINE) SULFATE AND CAFFEINE ON THE PERFORMANCE OF RAPIDLY EXHAUSTING WORK BY UNTRAINED SUBJECTS*

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IT HAS been reported[1-3] that amphetamine sulfate, d-desoxyephedrine hydrochloride and caffeine increase endurance to muscular work of the type that is performed by trained subjects during a hike or a march with a pack. Caffeine has been shown to increase the rate of recovery in trained subjects after an exhausting ride on the bicycle ergometer.[3] We desired to ascertain the effect of amphetamine and caffeine, given one hour before the work period, on the output of work in *untrained* male subjects doing rapidly exhausting work.

METHOD

Twenty-three untrained male subjects were used. They reported to the laboratory one hour before each first work period to take their capsules. These contained a placebo, or 10 mg. of amphetamine, or 0.5 Gm. of caffeine sodium benzoate and were indistinguishable from one another.

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The work was done by having each subject step up on a 16 inch wooden stand with one leg and down on the same leg once every three seconds until he could no longer maintain this rate. Each subject carried a knapsack on his back which was loaded, to the nearest 5 pounds, with a weight equal to one-third of his own weight. Each subject would work to fatigue, rest for three minutes on a near-by bed, then work to fatigue again. This procedure was carried out three times on each subject with at least a day's rest in between. One time the subject received the placebo; one time he received the amphetamine; and one time he received the caffeine. The subjects were staggered so that at the end of each double work period approximately one-third of them had received the placebo, another one-third the amphetamine, and the other one-third the caffeine.

SUMMARY OF WORK EXPERIMENTS

(23 Subjects)

TABLE I

EFFECT OF DRUGS

	1ST WORK PERIOD		2ND WORK PERIOD		TOTAL WORKING TIME		% RECOVERY	
	RANGE	AVERAGE TIME	RANGE	AVERAGE TIME	RANGE	AVERAGE TIME	RANGE	AVERAGE
	seconds		seconds		seconds		seconds	
Placebo	60-371	189	55-304	107	124-629	296	14-95	61
Amphetamine	83-513	203	46-305	112	134-818	315	20-96	60
Caffeine	56-520	181	42-272	104	102-765	285	33-86	61

TABLE II

EFFECT OF TRAINING

	1ST WORK PERIOD		2ND WORK PERIOD		TOTAL WORKING TIME		% RECOVERY	
	RANGE	AVERAGE TIME	RANGE	AVERAGE TIME	RANGE	AVERAGE TIME	RANGE	AVERAGE
	seconds		seconds		seconds		seconds	
Experiment 1	56-251	142	42-184	84	102-411	226	20-91	63
Experiment 2	60-361	166	55-201	96	115-629	262	38-95	61
Experiment 3	102-520	265	69-305	144	178-818	409	30-96	59

RESULTS

The results are to be found in Tables I and II. In Table I are the data showing the results with the placebo, amphetamine, and caffeine. As is evident there is no significant difference between the three. In Table II are the data showing that the subject's work output improved with practice. It is evident, then, that training had a much greater effect on performance than did the drugs. It will be noted that the general per cent recovery remains very constant in both tables. Table II, however, shows a tendency for it to decrease as the work output of the first period increases, which is in keeping with what we have found to be true in the past.[3]

The drugs produced no side effects, except that they caused most of the subjects to report that they felt euphoric and as if they could do a "lot of work today." The euphoria, however, did not permit them actually to do more work of the type performed.

CONCLUSIONS

1. In this experiment the effect of training overshadowed any effect the drugs may have exerted. This type of test is inadequate to determine the effect of the drugs used on work output. The *experiment emphasizes the importance of training.*

2. The average per cent of recovery in this series is very constant.

3. The average per cent of recovery tends to decrease as the average work output of the first period increases.

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THE INFLUENCE OF AMPHETAMINE (BENZEDRINE) SULFATE, d-DESOXYEPHEDRINE HYDROCHLORIDE (PERVITIN), AND CAFFEINE UPON WORK OUTPUT AND RECOVERY WHEN RAPIDLY EXHAUSTING WORK IS DONE BY TRAINED SUBJECTS*

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INTRODUCTION

SINCE it was found by Foltz, Schiffrin, and Ivy[1] that practice or training overshadowed any effects that amphetamine and caffeine may have exerted on the work output of untrained subjects doing rapidly exhausting work, this study on trained subjects was undertaken. It has been shown that caffeine increases the rate of recovery from exhausting exercise in trained subjects.[2]

METHODS

Four medical students were used. They were provided with board and room in a hospital near the laboratory. Their food intake was under control; their diet was adequate in all known components, a certain variation in the selection of food items being permitted. The subjects were chosen on the basis of their willingness to cooperate, and not on the basis of muscular development, the work of the tests being their only source of physical exercise. The double work periods occurred on Monday, Wednesday, and Friday afternoons at the same time between 2 and 4 o'clock. The subjects worked on the bicycle ergometer described by Kelso and Hellebrandt,[3] at a rate of 1,235 kilogram meters (kg.m.) per minute, with a pedaling rate of 54 r.p.m.

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Aided by the Abbott Fund of Northwestern University.

The periods of training of the subjects prior to performing these tests varied from three to sixteen months. The subjects worked to complete fatigue, rested ten minutes, and then worked to complete fatigue again.[2] The end point of fatigue was the point at which they could no longer hold the needle on the dial at the rate of 54 r.p.m.

The amphetamine (10 to 15 mg.), desoxyephedrine (5 mg.), and caffeine sodium benzoate (0.5 Gm.) were always administered intravenously. They were given at various times (thirty seconds to 30 minutes) prior to the first work period to determine their effect upon work output, and amphetamine and desoxyephedrine were given immediately after the first work period to determine their effect upon recovery, as measured here, from fatigue. The effect of caffeine upon recovery is reported elsewhere.[2] Placebo injections (sodium chloride solution) were given at random as controls. All solutions were colorless. The drugs were given intravenously to obtain rapid action, and because this group of subjects had previously obtained various therapeutic agents by a similar route to control the rate of absorption.

RESULTS

Various subjective sensations were reported by the subjects. After the injections of amphetamine, two subjects felt definitely "keyed up," and both experienced more leg pain during and after the work periods. The other two subjects reacted identically to both placebo and amphetamine. Desoxyephedrine seemed to increase the leg pain in one, to decrease it in another, and to cause insomnia in three subjects. In one case, when it was given immediately after the first period, it seemed to dispel fatigue. This sensation of being rested would last until he had worked for about ten seconds in the second period, when he would begin to feel as tired as though he had only had a placebo injection, and his recovery was not enhanced. This is in contrast to the response of this subject to 0.5 Gm. of caffeine sodium benzoate, given in the same manner.[2] This drug would also stimulate the subject, but the stimulation would last throughout the second period, and greatly increase his recovery. After being given either desoxyephedrine or caffeine for the rest of the day, this subject would feel extremely alert, and would experience difficulty going to sleep at night. One subject complained of weakness and giddiness following the first work period, after having received desoxyephedrine prior to working, and one reported no sensations from the desoxyephedrine. All four subjects reported definitely stronger immediate subjective sensations from the caffeine and desoxyephedrine when the drugs were given before the first period than when they were given after the first.

The results obtained by giving the drug before the first period are shown in Table I. It is evident that the amphetamine had no significant effect. However, desoxyephedrine and caffeine definitely increased the work output. With the increase of work done in the first period, the expected decrease in per cent recovery occurred.[1]

The results obtained by giving the drug immediately after the first period are shown in Table II. In the case of amphetamine it appears that the work output was enhanced. However, if this were true, the increment would

be in the second period work output and the per cent recovery would be higher than that of the controls. Because these qualifications are not fulfilled, no effect can be attributed to amphetamine. In the case of desoxyephedrine the per cent recovery was increased over that of the controls. However, if this were significant, certain other data should be present; namely, the first period work output of both the desoxyephedrine and the control series would be approximately the same, or that of the desoxyephedrine would be more; the second period and total work outputs would be significantly increased in the case of the desoxyephedrine. Since such is not the case, it cannot be said that desoxyephedrine significantly increased recovery.

TABLE I

DRUG GIVEN BEFORE THE FIRST PERIOD

SUBSTANCE	TRIALS	SUBJECTS	DOSE IN MG.	1ST PERIOD WORK OUTPUT (KG.M.)	2ND PERIOD WORK OUTPUT (KG.M.)	TOTAL WORK OUTPUT (KG.M.)	% RECOVERY
Amphetamine	10	2	10-15	4,570	2,862	7,432	63
Control†	10	2	----	4,793	3,117	7,910	66
Desoxyephedrine	12	4	5	8,870	5,750	14,620	66
Control†	12	4	–	7,055	5,105	12,160	72
Caffeine	6	4	500	5,805	3,911	9,716	66
Control†	6	4	–	5,201	3,667	8,868	70

TABLE II

DRUG GIVEN IMMEDIATELY AFTER THE FIRST PERIOD

SUBSTANCE	TRIALS	SUBJECTS	DOSE IN MG.	1ST PERIOD WORK OUTPUT (KG.M.)	2ND PERIOD WORK OUTPUT (KG.M.)	TOTAL WORK OUTPUT (KG.M.)	% RECOVERY
Amphetamine	17	4	10	6,764	4,167	10,931	63
Control†	17	4	--	6,478	3,931	10,409	62
Desoxyephedrine	31	4	5*	6,660	4,692	11,352	70
Control†	31	4	–	6,790	4,510	11,300	66

*In six trials less was used.

†Variations in the work outputs of the several control series result from different stages of training.

SUMMARY

The effect of amphetamine, desoxyephedrine, and caffeine upon work output, and the effect of amphetamine and desoxyephedrine upon recovery in subjects doing rapidly exhausting work have been observed. All three drugs stimulated some of the subjects mentally, so that they felt "keyed up" and more alert. The immediate subjective sensations resulting from desoxyephedrine and caffeine were much more pronounced when the drugs were given to a nonfatigued subject than when given to a subject following exhaustion. Amphetamine did not enable the subjects to work longer, nor to recover more rapidly. Desoxyephedrine did enable the subjects to work longer, when it was given before work began, but it did not hasten recovery when given to the exhausted subjects. Caffeine also enabled the subjects to work longer and, in addition, hastens recovery when given to exhausted subjects.[2]

CONCLUSIONS

As measured by this method:

1. Ten to 15 mg. of amphetamine injected intravenously do not increase work output in the trained subject doing rapidly exhaustive work.

2. Five milligrams of desoxyephedrine injected intravenously into the nonfatigued subject increase work output.

3. One-half gram of caffeine sodium benzoate injected intravenously into the nonfatigued subject increases work output.

4. Neither 10 mg. of amphetamine nor 5 mg. of desoxyephedrine injected intravenously into the fatigued subject actually enhance the rate of recovery from heavy work carried to the point of "exhaustion"; caffeine in adequate doses does.[2]

5. When stimulants are employed, they should be chosen according to whether it is desired to increase the work output of unfatigued subjects, or to enhance the recovery of fatigued subjects.

The drugs in some instances definitely improve subjective feeling tone and cause the subject to feel as though he can and is actually doing more work.

It should be remembered that the foregoing observations pertain only to rapidly exhausting work, and not to the type of work performed during a march or while standing guard.

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PLANTAR REFLEX AS A CRITERION OF ENDURANCE*

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YOU HAVE just heard an authoritative and instructive discussion of the problem of fatigue and endurance by Dr. Dill. I am quite aware, therefore, that I am taking a measure of liberty in adding a few remarks of my own on the behavior of the plantar reflex following a prolonged locomotion as a criterion of endurance.

It is generally known that the Babinski sign or plantar extensor response of the big toe occurs as a result of a deficiency of the function of the corticospinal tract. It is usually taken as a sign of a grave disease; in fact, of a destructive lesion in the nervous system. Such a view, however, is incorrect. The extensor response of the big toe is normal in infants up to eighteen months of age. It is also elicitable in normal adults during a profound sleep. It is evident, therefore, that a Babinski sign need not imply necessarily a structural damage to the corticospinal tract, for it may occur in normal physiologic states. However, in individuals with a constitutional weakness or fragility of the nerv-

*Lecture XX, reprinted from *Collected Lectures* of the Seventh Postgraduate Seminar in Neurology and Psychiatry, first semester, Military Neuro-psychiatry, Metropolitan State Hospital, Waltham, Mass., 1942.

ous system, the Babinski sign occurs readily under varying conditions which ordinarily are insufficient to cause its appearance in the constitutionally well-endowed persons. It may occur, for example, after a prolonged exertion, such as a long march. I would like to make clear that potentially a Babinski sign may well develop in any individual if the amount of exertion and fatigue is brought to the point of severe exhaustion, or beyond that point. However, in the constitutionally inferior individuals it develops after a relatively small amount of exertion, insufficient to cause its appearance in normal people. The occurrence of a Babinski sign after an ordinary amount of exertion in a person otherwise appearing healthy is a cogent indicator of a constitutional inferiority of such a person, and may serve as a criterion of endurance. As a test of endurance it has the advantage of being technically simple.

The assertion of the significance of the "exertion Babinski" as a criterion of endurance is based on the following observations:

Three years ago Farrell and I[1] undertook to study the effect of exertion, and particularly of a prolonged locomotion on the plantar reflex in a group of young and healthy college graduates in a reserve officers' training camp, and in a group of the constitutionally inferior persons at a farm colony for mental defectives connected with Walter E. Fernald State School. The results were as follows:

In a group of 168 college graduates in a reserve officers' training camp the plantar reflex was examined before and after a march of fourteen miles during military maneuvers. Of the 168 men thus examined, a Babinski sign developed after the march in 12, or 7.2 per cent. In 10 of these young and otherwise healthy men, a Babinski sign developed unilaterally and in 2 bilaterally. Having thus obtained a relative measure of the effect of exertion upon the plantar reflex in a group of normal individuals, we have examined the plantar reflex before and after seven hours of ordinary farm work in a group of 229 adult imbeciles at the state colony. Of 229 mental defectives thus examined, a Babinski sign developed in 49, or 21.4 per cent. The incidence of exertion Babinski after a day of ordinary physical work in this group of constitutionally inferior persons was, therefore, three times that of its incidence in a group of college graduates after fourteen miles of forced march.

Effect of locomotion. When a group of 60 mental defectives selected among those in whom after a day of ordinary farm work the Babinski sign did not develop were put to a test of a march of ten miles, 13 per cent of them developed a Babinski sign. After a march of an additional fourteen miles, 23 per cent developed a Babinski sign. It should be evident that locomotion was a particularly effective mode of exertion, causing the Babinski sign to appear in certain predisposed individuals.

The incidence of an "exertion Babinski" is as high in individuals presenting other evidence of constitutional inferiority. Thus, last summer Semrad and I[2] examined the plantar reflex in 64 adult males with various forms of chronic psychoses, chiefly schizophrenia, before and after a walk of only six miles. After the walk 10 per cent developed a frank Babinski sign unilaterally or bilaterally.

When the factors underlying the occurrence of "exertion Babinski" were investigated closer, interesting facts came to light. It was found that the individuals who endured a prolonged locomotion *without developing a Babinski sign* showed a relatively normal time of development of locomotion in infancy. They walked at about the normal age of *one and a half years.* On the contrary, the individuals *who developed a Babinski sign* after exertion began to walk much later, namely, at an average of *two and a half years of age,* and those of them *who developed a bilateral Babinski sign* were the most delayed in the age of establishment of erect locomotion, for they learned to walk on the average as late as at *three and a half years of age.*

It should be quite evident, therefore, that in certain individuals the occurrence of Babinski sign under influence of exertion stands in direct relation to their constitutional endowment. It appears to be a pertinent indicator of the constitutional stamina of the individual. I believe this fact is of a distinct practical interest for military medicine. A soldier who after a march of a few miles or at the end of a day of routine work develops an extensor response, especially a bilateral Babinski sign, regardless of his intellectual and physical status otherwise, should be considered a poor choice for an assignment to special task units in which physical endurance is a prime requirement, although this limitation does not preclude such a soldier to be proficient in other military services.

Concluding, I would like to emphasize that the occurrence of "exertion Babinski" has nothing to do with the "intelligence" of the individual. It may occur in mentally normal and physically healthy college graduates as well as in imbeciles and in psychotic individuals, although in the latter groups it occurs more readily and more generally than in the former group.

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MILITARY ASPECTS OF ALLERGY*

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THE advent of drafting men into the armed forces has brought with it the problem of allergy to confront the Army Medical Corps. Until now, problems involving allergic diseases have been minimized by the simple expedient of refusing to admit into the service all men with a history of a major allergy, and by discharging from the service those persons whose allergic problems became too troublesome. However, man power is important; it must be conserved and it must be utilized as advantageously as possible. The drafting of class IB men increases the problem of the conservation of man power, and the allergist is participating in the solution of this problem by aiding in the treatment and assignment of these physically inferior men to places and duties that will utilize to the greatest extent possible their abilities, and at the same time release for combat duty those men who are physically able to do the more arduous work.

In World War I the specialty of allergy was too new to attempt the solution of so vast a problem as was presented at that time. Allergy then had no official recognition, nor is it recognized officially by the Army at present. The result is that we possess rather poor statistics for most allergic diseases treated during the period previous to the present war. Fairly adequate statistics on asthma alone are available in Volume 15 of the statistical report of the Army Medical Department.[1]

During the last war the draft board rejections for asthma with emphysema and bronchitis averaged 2.45 per 1,000.[2] It should be noted, however, that not all asthmatics were included in this category, since associated emphysema or bronchitis was necessary for rejection. In the Army between April, 1917, and November, 1919, approximately 2.62 white soldiers per 1,000 and 5.60 colored soldiers per 1,000 were admitted to hospitals with the diagnosis of asthma; and 2,948 soldiers were discharged for disability arising from that defect. This represents 5 men per 100,000. Asthmatic cases caused the loss of 190,273 days. During World War I only 2 men per 1,000 were diagnosed as asthmatic, whereas fifteen years later 12 per 1,000 were receiving compensation for this ailment.

Since World War I the field of allergy has grown to such a proportion that it is now capable of dealing with questions of allergy as a distinct military problem. Thus, in place of the inadequate treatment of the past, allergic diseases are now diagnosed and adequate treatment is attempted. Reclassification is substituted for over-all discharges, and conclusions based on inadequate information are replaced by decisions having their foundation in known and proved data.

*From the Station Hospital, Fort Eustis, Virginia.

In World War II the latest statistics furnished by the office of the Surgeon General[3] indicate an annual admission rate of 2.57 per thousand per annum for allergic disease, the certificate of disability discharge rate is 0.40 per thousand per annum, and the death rate is nil.

From these statistics of World War I and II it is evident that the problem of allergy is not a small one and, considering its nature, very difficult.

The military aspect of allergy resolves itself into three separate problems. The first concerns itself with the professional duties of the Army allergist; the second with the correct distribution of allergists in the tables of organization of the medical department; and the third with the formulation of specific physical standards for all major allergic disorders.

The professional duties of the Army allergist deal with the diagnosis and prognosis of allergic diseases. A discussion of the routine methods of diagnosis used in the field of allergy does not fall properly within the realm covered by this dissertation. However, the prognosis of the ability of the allergic soldier must be considered, and it must be emphasized that this is the most important single task of the Army allergist. He, while attempting to perform this task successfully, must discover the answers to numerous and perplexing questions. Is the soldier fit for duty or should he be rejected or discharged? If fit for duty, does this mean full duty or limited service? If the conclusion is that the man is suited for limited service only, what are the services he is capable of performing and where can he perform them to the best of his abilities?

Not only is the allergist capable of handling the major allergies, such as asthma and hay fever, but his services are of indispensable value to the dermatologic, eye, ear, nose, and throat sections of his hospital. It is he who should investigate and control the contact skin problems, especially those cases involving poison ivy and "laundry dermatitis." Furthermore, many cases seen in these departments will respond promptly to an allergic regime but not to ordinary methods of treatment.

Inasmuch as the amount of serum and vaccine therapy is extremely great in the Army, the supervision of these therapeutic measures is a duty which should fall in the realm of the allergist. It is well known that all soldiers receive typhoid, smallpox, and tetanus prophylactic measures. If indicated, yellow fever, typhus, and cholera prophylaxis are administered. Methods of administration and control of reactions require constant supervision in order to minimize untoward reactions.

It is obvious that the correct distribution of allergists in the Army is of prime importance in the conservation of the material and men needed to carry on this type of work. Since the most important work of the allergist is concerned with the prognosis of a soldier's ability, it becomes evident that the allergist is best able to perform his duties where troops are inducted and trained. However, under the present organization of induction and reception centers, little time is available to the allergist to permit him to do more than eliminate those men who have no military value. It is rather at the training centers that the soldiers first come into contact with actual Army activities for

a period sufficient in duration so that they may be studied, their symptoms may be evaluated, and disposition of their cases may be made. Large general hospitals should also have allergists to take care of the allergic diseases discovered in the forward echelons.

The problem of allergy in the Army is further complicated because as yet adequate standards covering the allergic diseases have not been formulated by the Army Medical Department. This does not necessarily reflect adversely on the medical branch of the Army, but rather on the newness of the field of allergy. The formulation of an adequate allergy department must proceed slowly and must await the results and statistics uncovered by those medical officers sincerely interested in this field.

From a communication of the Surgeon General's[3] office regarding the physical requirements pertaining to the person suffering from an allergic disease, the following is taken:

"The physical standards for admission to the Army make no reference to specific allergic conditions other than hay fever. Individuals with mild hay fever are accepted for general military service, those who have moderate hay fever are accepted for limited military service, and those who have severe hay fever are rejected. Other important allergic conditions may be disposed of as indicated in Paragraph 5 *a* MR 1-9, revised October 15, 1942, which reads as follows:

'If any individual is regarded by the medical examiner as physically unfit for military service by reason of physical or mental defects not specifically noted in these regulations, he will nevertheless be recommended as unsuitable for general service or for limited service as the case may be. A brief statement of the reasons for the rejections will be entered on the report of physical examinations. So far as practicable, however, the physical classification of individuals will conform to the specified requirements.' "

To illustrate the problem of allergy in the Army, the statistics obtained at the allergy clinic at Fort Eustis, Virginia, from June 1, 1941, to October 1, 1942, are here presented and evaluated.

Table I represents the total number of cases seen at the allergy clinic and includes both outpatients referred to the clinic by the various infirmaries on the post and the hospitalized cases. No effort has been made to include in the tabulation those soldiers seen at the various infirmaries who were not sent to the clinic. The figures regarding the hospital cases were taken from the official diagnosis file kept by the registrar of the hospital and represent only those cases with the primary diagnosis as stated.

The total number of cases observed at the clinic represents approximately 1.5 per cent of all personnel at this post. It should be noted that this estimate is lower than is usually quoted; however, it is not a completely accurate reflection of the situation because undoubtedly many soldiers afflicted with minor allergies did not report to the infirmary or were not referred from the infirmary to the clinic. We may anticipate that over 1 per cent of all men entering the Army will require allergic care.

A perusal of the table indicates that the respiratory problems form the largest group among the allergic diseases; in fact, slightly over half of all allergic cases observed belong in this category. The greatest number of cases in this respiratory group are those of seasonal hay fever, these representing

slightly less than half of the total respiratory cases and 22 per cent of all allergic problems. The ragweed pollen cases far exceed those involving grass pollen; only a very few tree pollen cases have found their way to the allergy clinic. It is encouraging to realize that all the hay fever cases constitute a group for which excellent therapeutic results may be expected with only a moderate loss of man hours. The problem is still further simplified because there is a definite territorial ragweed belt. This belt is confined mainly to the areas of continental United States and Canada east of the Rocky Mountains (short and giant ragweeds), and thus all ragweed cases will be free from ragweed hay fever so long as they remain outside this area.

TABLE I

STATISTICS OF THE ALLERGY CLINIC, STATION HOSPITAL, FORT EUSTIS, VA.
FROM JUNE 1, 1941, TO OCTOBER 1, 1942

TOTAL CASES OBSERVED	NUMBER OF CASES	% CASES	HOSPITAL CASES	C.D.D.* CASES	ADMISSION RATE§ PER 1,000	RATE OF C.D.D.* PER 1,000
	1,833	100%	380	78	15.0	0.60
Respiratory Allergies	919	50.1	152	75	7.52	0.56
Hay fever	417	22.7	4	0	3.41	0.00
Asthma	289	15.7	92	75	2.36	0.57
Perennial rhinitis	161	8.7	51	0	1.31	0.00
Sinusitis (allergic)	28	1.5	†	0	0.23	0.00
Nasal polyps	24	1.3	5	0	0.20	0.00
Dermatologic Allergies	773	42.1	175	3	6.32	0.03
Contact dermatitis	346	18.8	110	0	2.82	0.00
Id type reactions	128	6.9	†	0	1.04	0.00
Urticaria	127	6.9	16	1	1.04	0.01
Dermatitis medicamentosa	76	4.1	15	0	0.62	0.00
Atopic dermatitis	57	3.1	32	2	0.47	0.02
Angioneurotic edema	39	2.1	2	0	0.32	0.00
Ophthalmologic Allergies	130	7.0	49	0	1.05	0.00
Conjunctivitis	104	5.6	23	0	0.84	0.00
Ulcerative keratitis	26	1.4	26	‡	0.20	0.00
Gastrointestinal Allergies	5	0.2	1	0	0.03	0.00
Migraine (allergic)	6	0.2	3	0	0.03	0.00

*Certificate of disability discharge.
†Not classified according to this diagnosis.
‡One case transferred to Walter Reed General Hospital.
§Admission rate to clinic per 1,000 men on post.

The policy of this clinic regarding these cases has been to continue treatment of all persons who have previously received medical care for this disease. Many cases have been treated preseasonally or perennially prior to induction into the Army. The cases of mild severity have been treated symptomatically with eye drops, nose drops, or ephedrine by mouth as is indicated. The moderately severe and severe cases are treated coseasonally with small doses intradermally accompanied by symptomatic treatment. Almost all these soldiers were treated in an ambulatory fashion; only four cases were hospitalized. Those men who suffer severely were instructed to secure perennial treatment as long as they remain in the ragweed belt. The results of therapy have been exceedingly gratifying.

Although the asthmatic group represents only 15.7 per cent of all allergic cases observed, this group nevertheless poses the most difficult problems. It is here that the allergist must be extremely perspicacious in order to attain correct disposition of the case. It is our opinion that practically all asthmatics, except those of mild seasonal type, should be reclassified into limited service.

In our clinic we have divided our asthmatic patients into four classes: first, the seasonal asthmatics; second, the old chronic asthmatics with or without secondary complications who have never been capable of pursuing a civilian occupation without a great deal of lost time; third, mild asthmatics who have been able to accomplish useful work in civilian life without undue loss of time; and fourth, those asthmatics who have had their first attack while in the Army. The seasonal asthmatics are treated similarly to severe hay fever cases, and no doubt can do well in foreign service, especially with noncombatant units. Old chronic asthmatics with secondary complications should be discharged from the service as soon as the diagnosis is made. Therapeutic results with this class are very unsatisfactory under military conditions. Asthmatics who have never been successful in civilian employment can hardly be expected to be of any greater value in military service. Thus, it is extremely beneficial both to the Army and to these men that they be discharged as promptly as possible. Those asthmatics without complications who have been able to follow a vocation in civilian life without undue loss of time are reclassified for noncombatant duties. The positions to which they are assigned should simulate their civilian occupations as closely as possible. These men can be hyposensitized and a rather moderately effective allergic regime can be instituted because their reclassification into noncombatant units makes treatment possible. Territorially, these men can be restricted to specific areas.

The last class of soldiers suffering from asthma includes those persons whose cases in the asthmatic group are the most difficult to handle. These men have had no or few previous attacks. They generally possess a past history of some allergic manifestation and a familial history of allergy. These cases should be skin tested for those materials which they now encounter in their new Army environment. One must always keep in mind the high concentration of certain substances in the barracks, e.g., feathers, tobacco smoke, mattress, blanket, and wood dust. Experience at this clinic has indicated that barracks dust is much more antigenic than ordinary house dust, and we have attributed this condition to the above-mentioned factors. It has been found that many patients allergic to barracks dust respond promptly to a coseasonal type of treatment, i.e., small frequent doses intradermally. If such measures do not evoke rapid and proper response from these men, they should be reclassified. Trials of duty are essential in forming an opinion in these cases. If the patients become progressively worse, they should be discharged from the service.

The remaining cases in the respiratory group may be termed harassing diseases. Persons falling in this category are frequently on sick call or are attending the ear, nose, and throat clinic. Many of these cases can be controlled by the judicious use of ephedrine drops, others by the elimination of the offending inhalant or by hyposensitization to the antigenic substance.

Nasal and sinus polyps may require surgical removal. Nevertheless, they should be examined from an allergic aspect and, if feasible, measures should be taken to prevent their recurrence.

The second large group of cases with which the allergy clinic is confronted consists of the dermatologic allergies. As might be anticipated, the cases of contact dermatitis occupy the predominant position. In this group the most habitual offender is poison ivy, and the parts of the body usually affected are the hands, arms, legs, face, and penis. The most efficacious therapeutic measure which should be instituted is prophylaxis, which is extremely simple because it can be accomplished by the use of material available to all soldiers—G. I. soap. If persons who are aware of their susceptibility to plants, or who know or suspect they have contacted poison ivy, will merely bathe with G. I. soap as soon as possible after contact, making certain to wash the parts of the body most frequently affected, much of the dermatitis venenata due to poison ivy will be eliminated. It must be emphasized that overtreatment of these cases produces unfortunate results. The value of the injectable extract of poison ivy twenty-four to forty-eight hours after contact is questionable, and is too costly for routine use beforehand. Most posts will have fewer casualties from this disease if by cooperative efforts of the allergist and post medical inspector there is an intelligent mapping and clearing of areas known to have poison ivy.

Wool is another important irritant. To determine whether or not a patient is sensitive to this material, a patch test, consisting of a patch of the wool underwear or shirt the soldier has been wearing, is used. However, such a test does not eliminate "laundry dermatitis." As has been reported in a previous article by the author,[4] the majority of our so-called "wool dermatitis" cases have been caused by laundry soaps and more recently by waterproofing fluid. "Laundry dermatitis" occurs more often where thick fabrics are involved, because, if woolen and cotton articles are subjected to an equal amount of rinsing, a greater proportion of the laundry materials used in washing will remain in the heavier than in the lighter garments. By enlisting the aid of the laundry officer so as to insure more thorough rinsing, the so-called wool dermatitis cases drop remarkably.

Other objects giving rise to contact dermatitis are the aluminum in the identification disks worn by the soldiers, the metal parts of watches, and the plastics used as wrist bands. There was one case of ulcerative stomatitis which was due to sensitivity to dentures, the patient being sensitive to all types of dentures except vitallium.

Urticaria is probably much more frequent than the reported figures would indicate because of the great number of vaccine injections administered in the Army and the drastic transformation undergone by a man who changes his status from civilian to soldier. This is because most of the hives are quite evanescent. The majority of the cases of hives seen at the clinic are those that have either lasted several days or are of the persistent or recurrent type. Most of those in the nonpersistent group clear quickly, but those of the recurrent type offer a very difficult diagnostic problem inasmuch as many cases are not allergic in origin. Other factors must be sought, especially those of a neurogenic character. It is rather astounding to note how much a chaplain's per-

sonal conversation with a patient, when accompanied by a little sedation, can accomplish in the way of alleviating a case of hives on a functional basis.

Atopic dermatitis cases should be handled in much the same way as the asthmatics. If a case is mild, tar ointments and moderate control will result in marked improvement; if moderate, the patient should be reclassified. The latter cases require definite allergic regimes and therapy which can only be given in the rear echelons. The severe cases should be discharged from the service, and this should certainly be the solution adopted after a trial of therapy and a trial of duty result in little or no improvement. Throughout any discussion of allergy in the Army, it must be remembered that each soldier represents a financial investment to the Government, and if the return on the investment does not warrant the expenditure, the sooner the financial operation is terminated the better for all concerned. It must also be recognized that of all the diseases, except venereal, confronting the Army, the dermatologic ones can destroy the morale of soldiers more rapidly than any other group of diseases. Men are exceedingly sensitive to deformities and to skin disorders both in themselves and in others. Thus, it is often wise to transfer from combat branches to service units those persons possessing unsightly skins if the skin disorders are of a permanent or semipermanent nature. This will prevent the disintegration of morale among the fighting divisions of the Army where morale is especially vital.

Dermatophytids of the hands are quite common in the Army, but they should be differentiated from other lesions, such as nummular eczema, contact dermatitis, and psoriasis. However, once dermatophytids are recognized, they respond exceptionally well to local treatment of the original lesion accompanied by intradermal doses of the fungus extract for the purpose of hyposensitization.

Many examples of drug allergies are seen at the post and these are especially noticeable in the wards of the hospital. At present, the sulfone drugs cause the most trouble. Cases involving drugs rarely represent an allergic problem except as a matter of diagnosis, and the diagnostician is hindered by the lack of good methods of testing. It is hoped that the latter problem will soon be solved by a more effective testing procedure than is presently employed.

Although the ophthalmologic allergies represent only a small group of the allergic diseases observed at our clinic, they are nevertheless quite fascinating. It should be noted that we have reported separately only those cases in this group devoid of concomitant symptoms. Thus, where conjunctivitis has been accompanied by hay fever, rhinitis, or asthma, the statistics have been included under the specific headings of the respiratory allergies. The majority of the cases of conjunctivitis were due to pollens and dust. Conjunctivitis may also be classified as an harassing disease because it leads to much physical discomfiture and thus decreases the efficiency of the soldier. Most conjunctivitis cases respond well to hyposensitization, but overdosage must be carefully avoided as keratitis may result. We have found small intradermal doses, combined with local treatment, to be most satisfactory.

As we have previously reported,[4] an unusually large number of ulcerative keratitis cases have been observed at this clinic. The clinical picture is that of small superficial ulcers located around the circumference of the cornea about

1 or 2 mm. from the limbus. These ulcers are very small and shallow, and are usually multiple; with progression they increase in size and coalesce and may form a continuous marginal ulcer. Marked conjunctivitis accompanies the keratitis. While pain is not usually present, itching may be intense. Central keratitis sometimes occurs secondarily due to lack of nourishment. Most cases respond well to hyposensitization, but hospitalization is indicated.

The gastrointestinal cases and the other minor allergies constitute interesting diagnostic situations for the allergist, but they are not significant as a military problem because of the small number of cases involved.

The statistics of the Station Hospital at Fort Eustis, Virginia, reveal that 1,833 cases were observed at the allergy clinic. This represents an admission rate to the clinic of 15 men per thousand for allergic study, treatment, and disposition. Slightly over 20 per cent of these cases were admitted to the hospital, or about 3 men per thousand were hospitalized for allergic disease. This figure compares favorably with the admission rate quoted earlier from the office of the Surgeon General of 2.57 per thousand. It must be noted, however, that as only a small proportion of the cases of major allergy were admitted to the hospital, the problem is actually much larger than is indicated by the admission rates to the various hospitals.

The total number of men discharged from the Army at Fort Eustis as being unfit for any military duty is 78, which represents 4.3 per cent of all cases seen at the clinic, or 0.60 men per thousand on the post. This also compares favorably with the certificate of disability rate of 0.40 per thousand, as reported by the office of the Surgeon General.

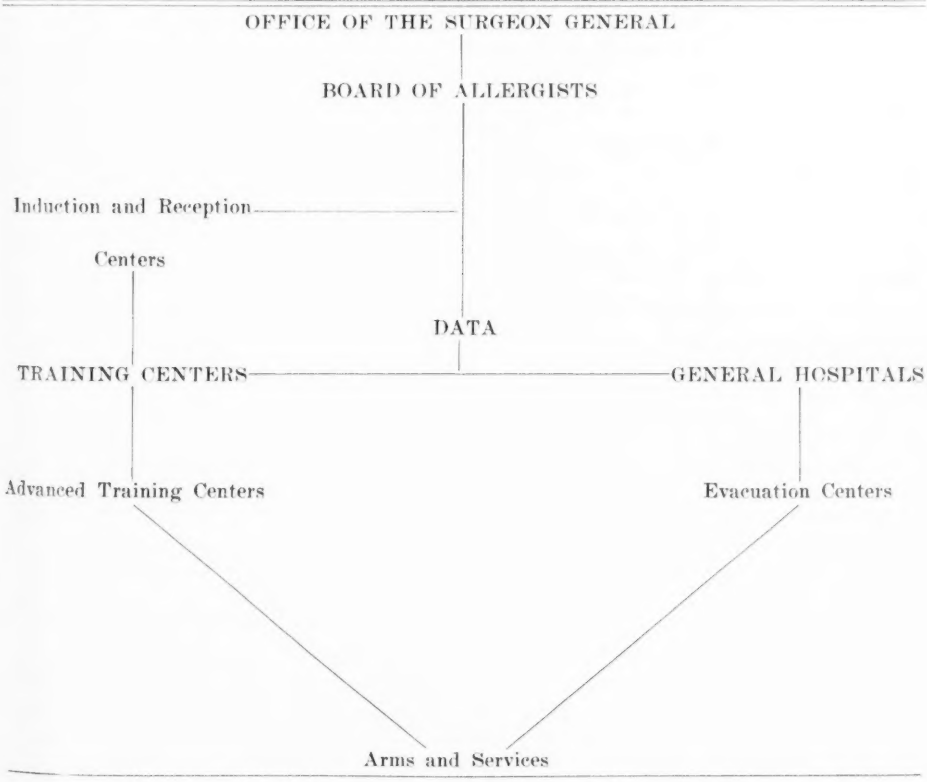
This dissertation is an attempt to present a comprehensive analysis of the military aspects of allergy in the Army. The study has led me to suggest the organization of the Army allergy service. I do not profess to possess the qualifications needed to set up the vast organization which would be required to take care of the thousands of men in the Army of the United States who suffer from allergic diseases, but I rather offer this suggestion with the hope that it will be of some constructive assistance in the solving of the problems of allergy in the armed forces.

The training camp is the focal point in the organization of Army allergy. As has been previously stated, training camps present the allergist with the first real opportunity to observed adequately the allergic patient. The allergist at such camps should be well trained not only in the routine diagnostic and therapeutic measures pertaining to allergy, but he should also have available all pertinent information concerning possible allergic factors present in all theaters of operation and in all branches of the arms and services. If persons suffering from allergic diseases are adequately dealt with by such specialists, the problem of allergy in forward echelons would be of slight significance.

However, it is inevitable that the allergic diseases of some persons will not manifest themselves until after the soldiers have left the training centers. Such cases can best be handled at the large general hospitals where competent allergists should be stationed. There the duty of the allergist should include the routine care and disposition of allergic patients, and it also should be incumbent upon him to collect pertinent data relating to the various allergic

factors of those areas which his hospital services. These data then could be gathered by a board or committee of allergists in the office of the Surgeon General, and subsequently evaluated and distributed to the various hospitals having an allergy service. Thus, without the necessity of maintaining a large organization, it would be quite simple to collect and to disseminate significant information concerning allergic factors present throughout many areas. The function of such a board or committee would be not only to correlate scientific data relating to allergic diseases but also to standardize material and procedures to be used in the diagnosis and treatment of allergic cases. Testing material would conform to specific standards, thereby eliminating variations found in the different extracts now being utilized. Accompanying the standardization of diagnostic procedures would be the realization that military needs must be of primary consideration. In this way, adequate and reliable data can be compiled, evaluated, and used for the purpose of solving the problem of allergy in the Army. Chart 1 diagrammatically represents the organization described.

CHART 1



As military allergy gradually becomes more comprehensible, definite physical standards for admission into the Army can be promulgated. The use of such standards would eliminate the necessity of having highly trained allergists present at induction centers. With the passage of time the field of allergic

diseases assumes greater importance in medicine. It thus becomes incontrovertible that the problem of allergy is one that must be met and solved.

SUMMARY

From this article, which is an attempt to analyze the problem of allergy confronting the Army Medical Corps, certain conclusions may be drawn.

1. Over 1 per cent of all soldiers entering the armed forces require allergic care.
2. The problem of allergy in the Army may be divided into three categories:
   a. The professional duties of the Army allergist.
   b. The organization of an allergy section in the Army Medical Corps.
   c. The formulation of specific physical standards for all major allergic diseases.
3. The professional duties of the Army allergist consist of:
   a. Diagnosis and prognosis of the capabilities of the allergic soldier.
   b. Treatment of allergic cases giving sufficient consideration to the allergic problems which confront the ophthalmologic, otorhinolaryngologic, and dermatologic sections of the Medical Corps.
   c. Supervision of vaccine therapy.
4. The organization of an allergy department is suggested. This organization should consist of first, a board of allergists to control activities, to collect, correlate and disseminate pertinent data and to standardize all material and procedures to be used in the allergy department; second, allergy sections should be established at training centers and general hospitals, the former to prognosticate and classify allergic patients according to their capabilities, and the latter to collect significant data relating to the district they service and to handle cases arising after soldiers leave the training centers.
5. Inasmuch as the board at the office of the Surgeon General is the only body having available to it all the statistics regarding allergic diseases in the Army, it is that board which should formulate the specific physical standards to guide these Army physicians seeking to arrive at a solution of the problem of Army allergy.

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HEART DISEASE IN MIDDLE AGE*

LIEUT. COM. CHRISTOPHER C. SHAW, M.C., U. S. N. R.

IT HAS been said that "life begins at forty" but it might better be said that "life begins to go downhill at forty," for heart disease resulting from degenerative changes in the cardiovascular system is the most common, single cause of death and disability in the middle-age group between 40 and 65 years.[1] Disorders of the cardiovascular system which occur during middle life may be classified under three main headings:

1. Heart disease caused by infectious agents.
2. Heart failure resulting from metabolic and endocrine dyscrasias.
3. Cardiovascular disorders due to degenerative processes.

Within the first division one finds lesions of the cardiovascular system resulting from typhoid fever, syphilis, diphtheria, scarlet fever, bacterial endocarditis, glomerulonephritis, pyelonephritis, tuberculosis, and lead poisoning.

Of these infectious diseases involving the heart and blood vessels during middle age, syphilis is of prime importance. The Spirochaeta pallida attacks the myocardium and aorta and larger arteries in the general systemic invasion which follows shortly after the initial lesion, or chancre, appears. The organisms are distributed throughout the body and remain quiescent in the cardiovascular tissues during the long period of latency which precedes the onset of tertiary syphilis. When the signs and symptoms of cardiovascular lues appear they may develop with almost explosive violence.

The pathology in the myocardium consists of either a diffuse inflammatory involvement of cardiac muscle tissue with progressive congestive failure or the development of gummata with destruction of the intrinsic nervous pathways and subsequent arrhythmia, often in the form of heart block. The diffuse myocarditis alone may be a cause of sudden death in middle age.[2]

Invasion of the arterial tree by the spirochete of lues centers about the root of the aorta and begins as an obliterating arteritis of the vasa vasorum with subsequent necrosis and degeneration of the media of the aorta (a mesaortitis). This process continues and may cause formation of an aneurysm, or produce insufficiency of the aortic valve, or encroach upon the ostia of the coronary arteries which arise in the sinuses of Valsalva.

Aneurysmal dilation of the aorta may be either saccular or fusiform but in either case places practically no burden on the heart. Aneurysms cause symptoms only when they erode bone—ribs, vertebrae or sternum—or impinge upon vital structures in the mediastinum. Their presence, however, is a harbinger of death due to the danger of rupture with sudden exsanguination, or

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the possibility of slow hemorrhage from necrosis and perforation of the aneurysmal wall. Insufficiency of the aortic valve and coronary stenosis produce typical clinical syndromes and require no further elaboration at this point.

Unfortunately for the patient and for the clinician, cardiovascular syphilis frequently develops in the presence of a negative Wassermann so that the diagnosis (and treatment) cannot be established by serologic tests. This probably occurs in 15 per cent to 20 per cent of luetic patients with cardiovascular syphilis, and is most likely the result of inadequate therapy during the primary and secondary stages of the disease. The treatment received was sufficient to reverse the positive Wassermann at that time but insufficient to prevent the development of cardiovascular involvement 10 to 20 years later, in spite of the fact that the patient's blood serology continued negative. In such instances, the doctor must lay great stress on the history of venereal infection and specific antiluetic therapy in youth and not be guided too strongly by repeatedly negative blood reports during middle age. Treatment should be directed toward alleviation of the congestive failure first, and then supplemented by careful administration of spirocheticidal drugs. The prognosis is poor in any form of cardiovascular syphilis.

With the exception of disease of the thyroid gland, metabolic and endocrine disturbances such as gout, obesity, pituitary, and adrenal tumors are relatively rare in older pilots and for this reason will not be considered in this discussion. Thyrotoxicosis, however, produces certain disturbances in the circulation which are worthy of comment.

The increase in metabolism due to an altered or toxic secretion of the thyroid hormone whips up the general circulation, causes slight peripheral dilatation, and increases the pulse pressure. The metabolism of the heart muscle itself is also elevated and results in a marked rise in the pulse rate with proportional decrease in the length of the diastolic phase of the cardiac cycle. The combination of these factors throws a tremendous load on the myocardium which will eventually show signs of congestive failure unless and until the toxic secretion is reduced by administration of iodine and then ablated by subtotal thyroidectomy.

In deficiency of the thyroid gland the patient becomes myxedematous, and as a result of the lowered metabolism the myocardium becomes soft and flabby and sluggish and unable to maintain an adequate circulation. Congestive failure will result but can be promptly mended by administration of thyroid extract by mouth. The basal metabolic rate is an index of diagnosis and of adequate thyroid medication in such cases. Sudden cardiac death has been reported in untreated myxedematous patients.[2]

Finally, mention must be made of the importance of masked hyperthyroidism in heart disease.[3] This possibility should be borne in mind in all cases of congestive failure which fail to respond to bed rest and adequate doses of digitalis. Such patients often exhibit transient auricular fibrillation, nervousness, loss of weight, tremors, and excessive perspiration and yet they present no exophthalmos nor enlargement of the thyroid gland. Blood pressure readings, pulse pressure, and pulse rate are frequently found to be within normal

limits in spite of the dyspnea, cyanosis, and edema which alarm the patient and confuse the physician. Low-grade glycosuria and mild diarrhea may also be present.

The basal metabolic rate in such cases will be elevated to +30 or even to +70 and will determine the true cause of the failure of the heart.[3] When masked hyperthyroidism is engrafted upon a heart already embarrased by previous disease—rheumatic fever with mitral stenosis or coronary occlusion with infarction—the differential diagnosis requires clinical acumen of a high order. The first syndrome may dovetail into and almost completely obscure the second. When the two conditions are found to coexist—based on repeated basal metabolic rate determinations—treatment should be directed toward the control and removal of the "masked" thyrotoxicosis.

By far the largest and most difficult field of heart disease in middle life comes under the heading of the "degenerative processes." This is especially true since the exact cause, or causes, of vascular degeneration are not known. However, because of the magnitude and importance of the problem, a short review of the salient points may not be amiss, even though our present knowledge of the subject is far from complete.

Degenerative diseases of the cardiovascular system include arteriosclerosis, coronary disease and angina pectoris, hypertension, and hypertensive heart disease. In this same category most authors include *cor pulmonale* and chronic nonvalvular heart disease, or chronic myocarditis.

Recent studies indicate that the underlying factors in all these degenerative states are heredity and the wear and tear of existence caused by the physical, mental and nervous strains of living and making a living in the twentieth century. The adage, "a man is as old as he feels," might be more truthfully paraphrased to read, "a man is as old as his arteries," that is, as old as the quality and function of his vascular tree inherited from his ancestors.

At the present writing, medicine has no control over heredity, although it is constantly striving to patch up inherited defects. By the same token, little can be done to control the speed of modern living or to lessen the wear and tear on the cardiovascular system incident to high-speed flying in modern military aviation. Both the strain and the stress are plunging forward at relatively increasing velocities and show no immediate evidence of reaching a reasonable equilibrium. And the cardiovascular system pays the piper in the long run. Sometimes the nervous system goes bankrupt first; but even in this case, the scars of battle have already left their indelible mark on the heart and blood vessels.

The most frequent "mark" is the atheromatous plaque of arteriosclerosis which is a manifestation of senescence of vascular tissue. The underlying cause probably will be found in a faulty metabolism of cholesterol, as it has been shown that the cholesterol content of the thoracic aorta increases with age.[4] This degenerative process termed "atherosclerosis" may be general in distribution involving all the arteries of the body from the largest to the very smallest, or it may be localized in one or more specific areas such as the brain, the coronary vessels of the heart, or in the kidneys.

As the vascular degeneration progresses, there develops a relative ischemia of the tissue supplied by the atherosclerotic vessel. If the process is gradual, a more or less efficient collateral circulation may be established which will serve to mask for a time the insidious and progressive nature of the atheromatosis. On the other hand if the diminution of blood flow to a part or organ be sudden or complete, as in thrombus formation over an ulcerated sclerotic plaque or in fracture of a calcified atheroma with embolic phenomenon, then infarction of the tissue peripheral to the sudden occlusion results. In either instance the end picture is primarily a diffuse or localized fibrosis of the parenchyma.

Vascular degeneration in the brain caused by atherosclerosis gives rise to the signs and symptoms of cerebral arteriosclerosis. In the kidney the disease may remain quiescent until the rather sudden onset of marked renal impairment or progressive renal insufficiency appears.[2] Arteriosclerosis of the vessels supplying the pancreas gives rise to a true diabetes which is usually comparatively mild. In the extremities the process produces causalgia and intermittent claudication. Thrombosis and/or embolism rapidly lead to gangrene.

Arteriosclerotic aortitis is usually symptomless until the process invades the ring of the aortic valve causing stenosis, or unless the coronary ostia in the sinuses of Valsalva are impinged upon by atherosclerotic plaques. An aneurysm of the aorta due to arteriosclerosis may be a simple, diffuse, silent dilatation or it may occur as the dissecting type which is spectacular, excruciatingly painful, and usually causes sudden death from shock or from rupture of the aorta in a few hours or days after the sudden and dramatic onset of the dissection of the media.

Atheromatosis of the coronary vessels leads to coronary insufficiency and occlusion with impaired cardiac efficiency due to myocardial ischemia and infarction. In this connection it is interesting to point out that coronary occlusion *per se* does not necessarily produce any characteristic clinical manifestation.[5]

If the occlusion develops very gradually (as it may in atherosclerosis), nature will improve the opportunity to develop or expand the potential collateral circulation in the heart muscle and produce anastomoses sufficient to prevent, or circumvent, infarction of the myocardium. This is brought about by opening of the Thebesian capillaries coursing within the muscle bundles and by the propagation of vessels from the circulation of the pericardium at its attachment near the base of the heart.

The extent and efficiency of this collateral circulation have not been generally realized, but its importance is evidenced by the fact that it is found operative in approximately one-fourth of the patients with coronary occlusion.[1] Their lives have been prolonged for years and they may have remained symptomless because of the very chronicity of their vascular degeneration. At postmortem examination extensive atherosclerosis of the coronary vessels may be present out of all proportion to the clinical manifestations.[6] Cases are on record in which one or both coronary arteries have been found completely occluded at autopsy, yet the patient remained free of symptoms referable to the heart during life and succumbed from noncardiac causes.[1]

If, on the other hand, the occlusion occurs rapidly, the classical picture of myocardial infarction develops. This is characterized by substernal pain and oppression due to anoxia of the infarcted area of heart muscle.[7] There is concomitant fall in blood pressure, pallor, shock, fever, leucocytosis, pericardial friction rub and typical electrocardiographic changes. In such cases the clinical diagnosis is usually coronary thrombosis, but the term "myocardial infarction" would be more accurate.

Pain is commonly an outstanding symptom of this syndrome and frequently is crushing or grinding in severity and of prolonged duration. In other cases pain may be notable by its absence, since there are certain areas along the lateral wall of the left ventricle which are relatively silent as far as symptoms and signs and electrocardiographic evidence of infarction are concerned. Many cases of painless myocardial infarction have been recorded in which the only complaints were sudden dyspnea and progressive congestive failure.[8]

Sclerosis of the peripheral vessels is not a true cause of heart failure, for it has been shown that extreme degrees of peripheral arteriosclerosis have no deleterious effect on cardiac function;[3] nor is there necessarily any relationship between peripheral and coronary vascular degeneration. The former may exist in the entire absence of the latter, and, conversely, coronary atheromatosis may be present to the point of death and show no evidence of narrowing or tortuosity or induration of the peripheral arteries, nor of the retinal vessels in the fundi. The term "arteriosclerotic heart disease" is, in a sense, a misnomer and should be dropped in favor of the more truly descriptive phrase "coronary artery heart disease."[3]

Angina pectoris manifested by substernal or precordial pain of agonizing character and short duration is a symptom complex and not a disease entity. It is the consensus that it results from anoxia of the heart muscle[7]—in other words, a cardiac "cramp"—which may be brought about by angiospasm or by partial occlusion of a coronary artery or one of its branches. Vasospasm occurs in about 10 per cent of patients suffering with angina and is induced by hypersensitive nervous mechanisms, by thyrotoxicosis, by ingestion of certain poisons, and by excessive inhalation of nicotine. Coronary thrombosis with anginoid pain is three times more prevalent in heavy smokers than in nonsmokers during middle age.[1] In 90 per cent of the cases diagnosed "angina pectoris," degenerative disease of the coronary arteries can be demonstrated.

A word of caution in regard to the close association between arteriosclerosis and hypertension. It is definitely accepted that arteriosclerosis does not produce hypertension. Hardening of the peripheral vessels alone is conducive to hypotension rather than high blood pressure since the elastic recoil of the arterial wall is greatly reduced by atheromatous infiltration of the intima. Arteriosclerosis may, therefore, exist for years without any rise of blood pressure. On the other hand, hypertension cannot be present for long without producing degenerative changes in the vascular tree. Hence it is difficult to say whether the high blood pressure caused the arteriosclerosis or whether the

unknown cause, or causes, of the hyperpiesis exerted a concomitant deleterious effect on or within the intima of the blood vessels.

Be that as it may, the actual cause of hypertension still remains a mystery. Numerous theories have been applied to the problem but all have been found wanting. The most rational hypothesis deals with the irritability of the arterioles causing vasospastic constriction which produces a proportional increase in peripheral resistance and this in turn necessitates an increase in hydrostatic force—that is, an elevation of the blood pressure—to cope with the augmented or heightened resistance in the peripheral circulation.

During the past decade considerable experimental work has been done on this problem, and it has been shown repeatedly that experimental hypertension can be produced by renal ischemia.[9-12] Furthermore, this rise in blood pressure (produced experimentally) is of humoral origin and arises as a result of the presence of an excessive amount of pressor substance in the circulation. This pressor substance is not actually produced in the ischemic kidney but rather is a combination of a precursor (renin) liberated by the damaged kidney and an activator (angiotonin) already in the blood.[13] Moreover, this pressor substance (hypertensin) acts directly on the arterioles to produce vasoconstriction. The clinical application of this recently acquired knowledge is, like prosperity, probably "just around the corner." In the meantime the clinical problem of hypertension—both the benign and the malignant type—continues to baffle the internist.

A confusion of tongues has arisen in the matter of nomenclature. The terms "malignant sclerosis," "malignant hypertension," and the "malignant phase of essential hypertension" all refer to the same syndrome. High blood pressure is not a disease entity but rather a symptom complex in which the hypertension is either primary (essential) or secondary to any one or any combination of a number of different diseases. This concept is not generally entertained but its validity is attested clinically by the fact that in the long run the *modus operandi* of every case of hyperpiesis is identical, no matter what its pathogenesis is or may have been. The malignant phase frequently develops after hypertension in the benign form has been present for a variable length of time, perhaps even unsuspected.

In a small percentage of patients hyperpiesis may apparently be malignant from its onset. This is termed the *de novo* form of the disease and may occur explosively in certain cases of primary hypertension or develop quite dramatically in patients who for many years have suffered from latent renal disease without any previous increase in their blood pressure.[14]

The onset of the malignant phase of hypertension (be it "primary" or "secondary") is characterized by severe headache, visual disturbances, vomiting, anorexia, cachexia, and exhaustion. These signs and symptoms in the presence of a systolic pressure bordering on 200 mm. Hg and a diastolic pressure in the neighborhood of 110 mm. Hg, or higher, predict a progressively rapid failure of the cardiac or renal functions. Patients with hypertension are all potential cardiacs or nephritics. Their clinical course is downhill (rapid in the essential or malignant type; slow in the benign or secondary form) and almost always terminates fatally in cardiac failure, or in apoplexy, or in uremia.

Patients suffering and dying from hypertension, or the effects thereof, can be segregated into several well-defined etiological and pathological groups, depending on the pathogenesis of their underlying disease, as follows:[14]

1. Primary or essential hypertension (cause, or causes, still in doubt).
2. Secondary hypertension due to—
   A. Renal disease:
      a. Glomerulonephritis.
      b. Pyelonephritis.
      c. Intercapillary glomerulosclerosis.
      d. Congenital unilateral hypoplasia.
      e. Obstruction of renal artery by atherosclerotic plaque.
      f. Multiple occlusions of small renal arteries.
      g. Renal infarct.
      h. Periarteritis nodosa of renal vessels.
      i. Polycystic kidneys.
   B. Chronic lead poisoning.
   C. Polycythemia vera; leucemia.
   D. Endocrine disease.
      a. Pituitary—basophilic adenoma.
      b. Adrenal—hypernephroma; paraganglionoma.
      c. Thyroid—thyrotoxicosis.
      d. Hyperemesis gravidarum.

Time and space do not permit further elaboration of the factors listed in the table. During life it is usually impossible to tell whether the patient is suffering from hypertension which is primary unto itself or is secondary to some unrecognized morbid lesion. Whatever the nature of the underlying pathological process, the prognosis is poor either in the long or the short run. Treatment is purely palliative except in those rare cases where the renal or glandular pathology is amenable to surgery. The results of sympathetic surgery in patients with the malignant form of hypertension have been uniformly disappointing.[15]

The term *cor pulmonale* refers to failure of the right ventricle as a result of increased pressure in the pulmonary circuit. This may occur in the acute form following a large pulmonary embolus but more frequently is a chronic affair as seen in emphysema, silicosis, stenosis of the pulmonary artery, and in extensive fibrotic tuberculosis, or in spontaneous pneumothorax (especially when bilateral). These conditions, when they do develop, usually appear during middle life.[2]

Cardiac disease caused by avitaminosis and dietary deficiencies, such as protein starvation, is rare in this country but is a possibility among the civil population during wartime. Myocardial failure due to the presence of a peripheral arteriovenous fistula—the traumatic variety should present no diagnostic difficulty—to tumors of the heart muscle and to deformities of the spine and thoracic cage is so rare that it will practically never enter the physical picture of the aviator approaching middle age.

There is one form of chronic myocardial insufficiency, however which deserves mention because its etiology is not clear, because it is frequently overlooked, and because its onset is insidious and its course progressive.

This is a nonvalvular cardiopathy characterized by congestive failure of unknown cause. Clinically, there is no evidence of hyperthyroidism or emphysema or avitaminosis or protein deficiency or blood dyscrasia. Neither are there any signs or symptoms of infection of the endocardium, myocardium, or pericardium. Nor can vascular degeneration nor hypertension be indicted—and yet the myocardium tires out during middle age, either early or late, and runs down like an alarm clock and stops.

At autopsy, the heart is found to be both dilated and hypertrophied, but the heart muscle otherwise appears normal to all intents and purposes. For lack of a better name such cases have been termed "chronic myocarditis," which is another misnomer since no inflammation of the myocardium can be found. The term "chronic myocardosis" has been suggested[16] to account for the dyspnea on exertion, the flatulence after meals, and the mild precordial pain (transient but recurrent) which warn of impending congestive failure. These symptoms, however, are quite frequently found in many cardiac syndromes and should not be assigned (or consigned) solely to chronic myocardosis. It may be more satisfactory to designate this symptom complex by the term "nonvalvular heart disease," or simply "chronic myocardial insufficiency."

Since heart disease is so prevalent and ubiquitous in middle life and since it is the most frequent cause of death and disability between the ages of 40 and 65 years, its prevention and early detection are of paramount importance. This is especially true for the profession of aviation, for while it is significant that anoxia causes a rise in blood pressure and pulse rate equivalent to that produced by mild exercise only, it has been realized more recently that the chronic stresses of flying eventually induce a generalized (and rapid) deterioration of the cardiovascular system.[17]

In most instances this premise applies, not only for the aviator but for the entire personnel of the Navy. In the past 20 years, the Bureau of Medicine and Surgery has recorded an alarming increase in coronary disease. The age incidence in these coronary deaths is lowering year by year and the morbidity is getting higher.[18] McIntire[18] states:

> Are we crowding our officers to a point where the cardiovascular system can no longer carry its load, or are we piling on so much responsibility that the nervous system cannot maintain its stability? . . . In the Navy a man must be physically fit to perform his duties at all times, in all places and under any condition. . . . It is the duty of the internist to find means of preventing disabilities, especially those due to degenerative disease.

While the call to duty in this respect is clear, the means of fulfilling this phase of our mission still remain obscure. This, in part, may be due to the fact that many of the methods and instrumentalities of modern cardiology lack precision. Some of the problems in this field of internal medicine yield only to empirical solution—or remain unsolved. Others are forced to rely for an answer almost entirely on the patient's history, which may be accurate and intelligent, yet incomplete; or it may be inaccurate and, therefore, worthless. Many of the signs and symptoms are transient; others notoriously absent when needed most to clarify the diagnosis. Even our present laboratory methods are far from infallible. Much must still be taken (and given) "on faith."

Pending that happy day when detection, recognition, prevention, treatment and after-care of the patient with degenerative cardiovascular disease shall reach a more rational (and simpler) plane, we must use our present scanty knowledge of the problem to the best possible advantage. Many time-honored procedures have proved their worth and have behind them the authority of regulations; other and newer concepts and diagnostic methods deserve consideration and fair trial.

Determination of the fitness of the cardiovascular system for continued military service is difficult because the examiner must rely chiefly on signs alone, and often these signs are of questionable significance. Tachycardia, systolic murmurs, slight elevation of blood pressure may attract the attention of the examining physician. Usually these findings are of no particular importance, yet their presence demands careful investigation. Is the tachycardia due to nervousness or to the presence of a "hidden" infection (notably tuberculosis)? Is the elevation of blood pressure relative or absolute? Is it a precursor of essential hypertension? Does poor response to exercise indicate an impending effort syndrome? How can these questions—and a host of others—be answered unequivocally?

In an attempt to arrive at a reliable evaluation of the cardiovascular system of the middle-aged flier one must first have a base line on which to "base" his judgment. This may date back to the general physical examination at the time of his enrollment or commission.[19] In addition to the routine Schneider test and examination of the ocular fundi, an electrocardiogram and teleroentgenogram of the heart would be desirable. The cold pressor test and "circulation time" may provide important information on the "tone" of the peripheral vascular tree. Annual fluoroscopic examination of the heart and aorta and routine electrocardiogram every year after the age of 40 may some day be included in the *Manual of the Medical Department*.

In regard to the strain of modern living and the extra stresses placed upon the heart and blood vessels by commercial and especially by military aviation, little can be offered other than education and advice concerning the value of rest and the art of relaxation while off duty. Excessive indulgence in alcohol, tobacco, and other forms of dissipation are no respecters of persons or occupations. Such habits probably hasten the onset and speed the progress of degenerative diseases of both the cardiovascular and nervous systems.

The personnel of our armed forces who are approaching middle age must learn to acknowledge and respect their physical and nervous limitations. To grow old gracefully and graciously still remains an art which is worthy of cultivation and patronage. By so doing, our officers and men will be enabled to render better service to our country and live longer, more useful, and happier lives.

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RESPONSIBILITIES OF THE ARMY ROENTGENOLOGIST*

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NOT infrequently the statement is made: "Roentgenology is roentgenology whether it be practiced in the Army or out of the Army." At first thought, this expression might seem to specify adequately the situation. In many respects it is true.

Scientific practice of roentgenology requires deliberative analyses of projected images on films or a fluoroscopic screen; a mental or recorded listing of tangible findings—the evidence described as "roentgen criteria"; an evaluation of such findings with respect to one or another pathologic entity; and finally, a correlation of the possibilities with consideration of the clinical aspects and laboratory studies. The roentgenologist must be recognized as a consultant. As such he must have a grasp of the entire field of medicine. He must exercise judgment just as required of a surgical consultant or any other type of medical adviser. These requirements are common both to the Army roentgenologist and to his confrere practicing this specialty in civil life.

There are a number of subspecialized qualifications frequently required of the roentgenologist practicing in civil life, which cannot be expected as demands upon the Army roentgenologist. For instance, rarely would the Army roentgenologist be concerned with pelvimetry, gynecologic roentgenology, or studies

*From the Department of Roentgenology, Army Medical School.

of infants and children. Moreover, in the theater of operations it can be expected that he will seldom have to deal with the treatment of malignancies—though this latter responsibility must be handled in certain general hospitals located in the Zone of the Interior.

These exemptions are more than offset by other requirements. The Army roentgenologist must possess an exceptional degree of ingenuity and the ability to command men and to coordinate very diplomatically the roentgenologic service; the ability to discern diagnostic criteria by way of roentgenoscopy without requiring film evidence; familiarity with foreign-body localization; special diagnostic acumen in the field of maxillofacial abnormalities; and a familiarity with requisitioning and handling of supplies.

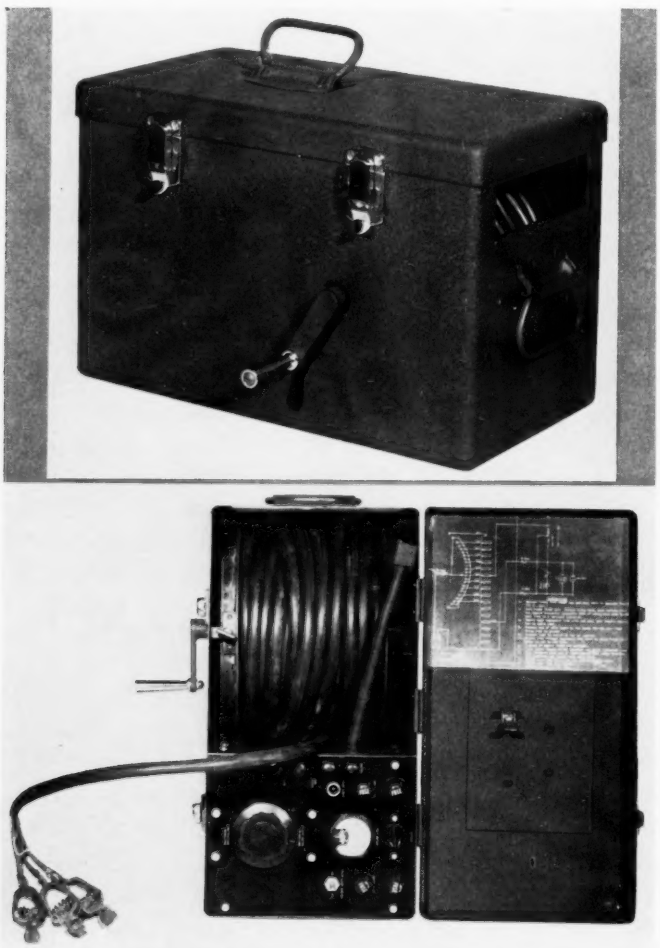
Let us consider the magnitude of special qualifications such as these.

At a general hospital the roentgenologic service can be expected to be similar to that of any large civilian hospital. Similar services might be required at a station hospital.[1] However, at a fixed or a motorized evacuation hospital, at a surgical hospital, at a convalescent hospital, or on a hospital transport ship, in any of these locations, it can be expected that the roentgenologist will have to assemble his equipment; he will have to adjust it to one and another type of electrical supply, possibly disassemble it, move to a new location, and repeat this process over and over. In most instances, when trouble develops he will have to analyze the nature of the trouble and probably repair it himself. True enough, he will have assistance by way of enlisted technicians, but in most instances such assistants will be of unknown trust, and even though eventually trained they must be considered as transient. At best, he will be dealing with strangers much of the time. True enough, there will be repair centers, but these may be located at a considerable distance and available only after much delay. Therefore, the Army roentgenologist must develop himself to a standard of self-reliance, not only with respect to diagnostic problems but also in the handling of equipment.

In this connection it might be mentioned that the type of electrical currents available in one or another part of the world is very variable. The conventional current as found in the United States, 110 volts, 60 cycle, single phase, is not available widely throughout the rest of the world. In some locations, even here in the United States, 50 cycle current is used; in a few locations, it is a 30 cycle current. In our own Canal Zone it is 25 cycle. In most parts of the world, 50 cycle current, with a voltage of 200 to 260, is supplied the communities. Moreover, the most common type is three phase rather than single phase.

It has not appeared to be practical to provide means for altering the cycle such as might be available in one or another locality, since equipment required for such conversions would have to be very bulky and very heavy. However, it has been deemed practical to provide for adjustment of the voltage and the phase. This can be accomplished by use of a portable autotransformer. This item weighs approximately 80 pounds. It has a 70 foot line cable of a gauge satisfactory to handle relatively high wattage under conditions of voltages of the 200 to 260 range, and its design is such that it can be connected into the higher voltage line and deliver the lower voltage for which the portable field x-ray equipment and many other electrical devices have been designed. It may

be connected into two leads of a three-phase circuit so as to deliver single-phase current. Fortunately, the Army field equipment has been designed for operation on either 50 or 60 cycle current. Thus, with the aid of this autotransformer, our field x-ray equipment can function in most parts of the world. Where the cycle is less than 50, a special portable gasoline-electrical generator, having a capacity for 2,500 watts, may be used. Larger capacity mobile generators are



A.

B.

Fig. 1.—The portable autotransformer unit. *A*, Showing packing arrangement; *B*, top opened, showing 70 foot cable ready for fixation to open leads such as available in a distribution box. Note the meter for indicating the voltage applied to electrical apparatus connected into the secondary circuit of the autotransformer winding.

provided wherever needed. The requirements can be expected to differ in one and another location, and constantly it will be necessary for the roentgenologist to deliberate as to what adjustments are indicated. In these problems he cannot depend upon factory personnel or local electricians.

All field x-ray equipment has been designed on the basis of several limiting axiomatic principles.[2] All of it is portable. That which is to be used farther forward than "fixed types" of evacuation hospitals is packed in field chests.

Originally, it was intended that no one of these chests when packed should weigh more than 200 pounds. Because of various requirements including limitations on priority of materials, it has been necessary to deviate from this fixed policy. However, no one chest packed weighs more than 357 pounds (the gasoline-electrical generator). All the chests are balanced and so constructed that they can be carried by two to four men. Each item has been designed for multiplicity of adaptation. Single purpose application has been considered impractical. Besides providing that each item be usable for many purposes, the policy has been to provide usefulness for any type of hospital installation and to meet any type of situation.

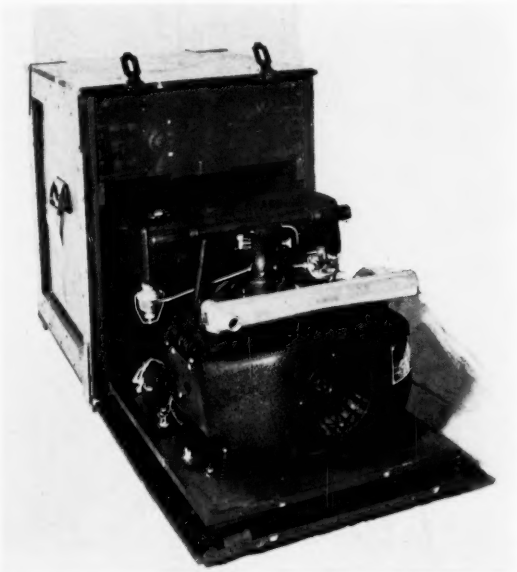


Fig. 2.—The portable gasoline electrical generator. Two gallons of gasoline provides for a supply of 2,500 watts continuously for approximately four hours.

For instance, the x-ray tent may be used for roentgenoscopy, with one arrangement of its inner curtain, or it may be used for film processing by merely changing the arrangement of its inner curtain and auxiliary drapes. Moreover, this tent may be erected by itself on the outside; it may be erected within another tent such as a ward or corridor tent, or it may be erected in any room or dugout. Under very windy conditions, it may be reinforced with the use of guy ropes. However, guy ropes and ground poles are not necessary. It is anticipated that in many instances dugouts or cellars will be utilized. The tent as well as all the other equipment can be adjusted quickly to such a situation. In fact, with forceful supervision and with very little training of three or four technicians, it is possible to move into a new location and to set up the entire equipment as needed for roentgenoscopy and to be ready to function within fifteen minutes after the time of arrival. This same equipment might be mounted onto closed trucks, thereby being made available for usage at a moment's notice.

The x-ray table unit, together with the x-ray machine unit and its chassis, has been designed for a nine-way adaptation. They may be adapted for horizontal roentgenoscopy; for a rapid roentgenoscopic method of foreign-body localization; for sitting roentgenoscopy; standing roentgenoscopy; horizontal roentgenography, with the tube above the table; horizontal roentgenography, with focal film distances as great as 6 feet, the patient being positioned on a litter at the floor

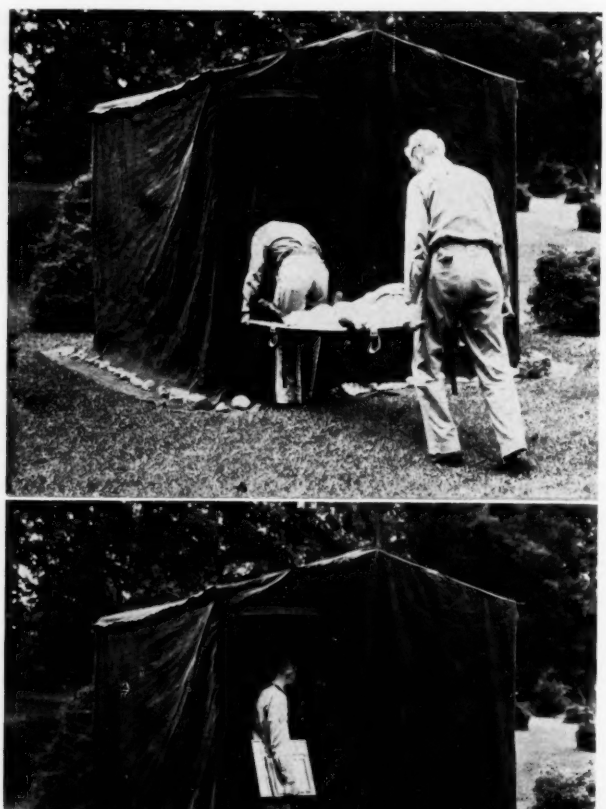


Fig. 3.—The darkroom tent: *A*, As erected for roentgenoscopy—note the forward position of the inner curtain. The litter bearers simply butt through four drapes. *B*, As erected for film processing—the inner curtain has been set back 22 inches; the inner drapes have been closed by way of a zipper so that the technician enters through labyrinth.

level; vertical roentgenography, using similar long focal film distances; bedside roentgenography (utilizing a mobile arrangement of the x-ray machine unit); and finally, this equipment may be used for roentgenotherapy for conditions requiring a quality of x-radiation, such as produced with a kilovoltage of 100—infections (including gas gangrene) and dermatoses.

All these applications must be understood, and the roentgenologist must be capable of quickly adjusting not only to new conditions but also to any of a

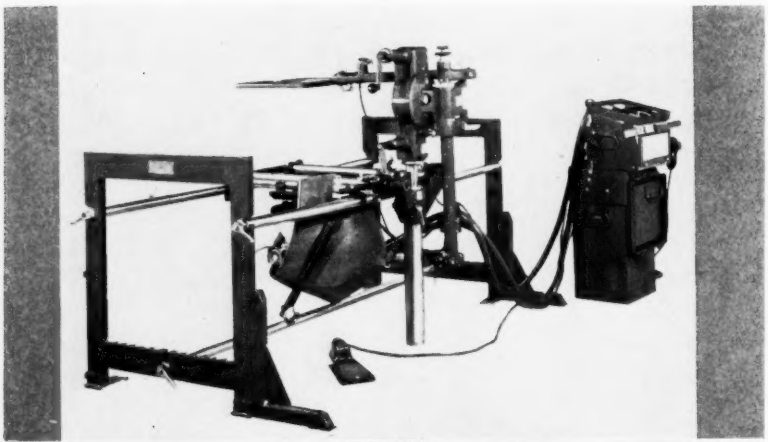
variety of demands with the minimum of equipment. In connection with foreign-body localizations, it should be emphasized that another item has been developed, a "biplane marker and reorientating device." This item is of a design such as to provide for its being adapted to the roentgenoscopic screen. It is designed to serve for spotting onto the skin of the patient, the location of the foreign body with respect to a plane at right angles to the plane concerned with the roentgenoscopic localization. This *second* spotting and localization are accomplished without any x-radiation exposure of the patient, and without the use of x-radiation at all. It provides for spotting of the position of the foreign body just as might be accomplished with the use of biplane roentgenoscopy. Yet, the shortcomings of biplane roentgenoscopy: the bulk of a second tube and second roentgenoscopic screen or the time delay concerned with shifting a single tube and screen from the first plane to one at right angles to it; difficulties of visualization of a small foreign body through great thicknesses and densities concerned with lateral planes, and the increased x-radiation exposures with respect to both the patient and the roentgenoscopist such as required for viewing in the two planes—all of these shortcomings are overcome with use of the biplane marker.

This "spotting" in the two planes serves for more definite guidance to the surgeon. It can be anticipated that the patient may be lying in one position during roentgenoscopy, whereas he might be rotated to a different position for the surgical approach. The surgeon may not appreciate these variations of relationship and he may, therefore, approach the foreign body along a plane at variance with the plane concerned with the alignment of the foreign body to the spotting on the skin surface. Perhaps, due to anatomic limitations, the approach may have to be from an altogether different plane relationship than either of two planes so far considered. In such cases, biplane marking itself should indicate the true relations and guide the approach.

In some instances, it can be expected that the surgeon must be assisted even further. It may be necessary to re-establish more thoroughly the relations on the operating table, as they pertained during the localization procedure. For this, the two spottings on the skin surface already mentioned may be used in connection with the re-orientating device to indicate very definitely relations for proper positioning. This device contains three adjustable probe directors. They can be detached for sterilization purposes and if needed they can be repositioned onto their respective supports and used right in the operative field under conditions of surgical asepsis. One probe may be positioned for indicating the plane with respect to the spotting as accomplished with the roentgenoscopic procedure; a second one may be positioned for indicating the plane concerned with the spotting as accomplished with the biplane marker; the third probe may be positioned for directing the plane of any operative approach that the surgeon might have selected. Thus localization may be accomplished with respect to *any* plane. The roentgenologist is charged not only with the "spotting" of the foreign bodies and calculating depth values with respect to them, but he must actually coordinate with the surgeon in accomplishing their removal.

These procedures do not require the use of films. All of them can be accomplished within time limits of a few minutes. Actual energization of the x-ray equipment and radiation exposure should not exceed fifteen to forty-five seconds,

A.



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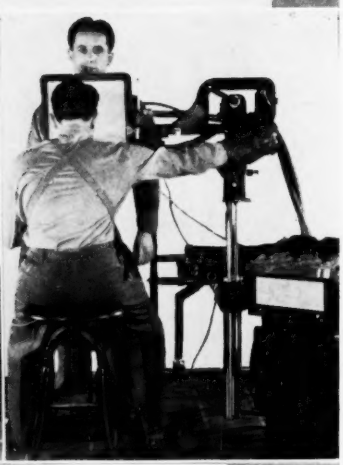
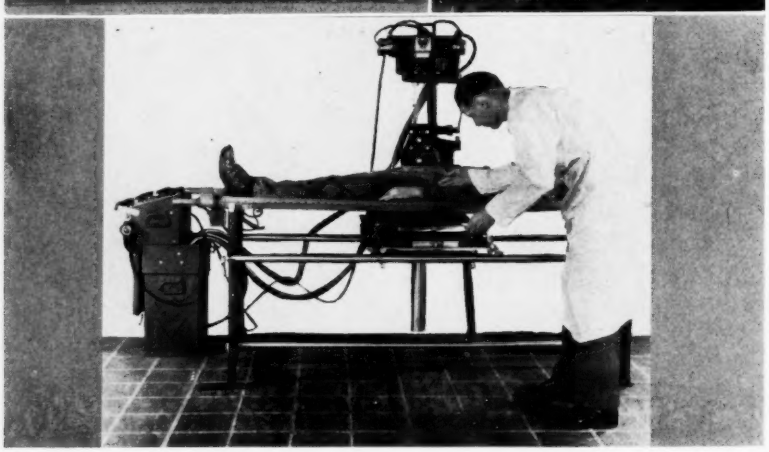
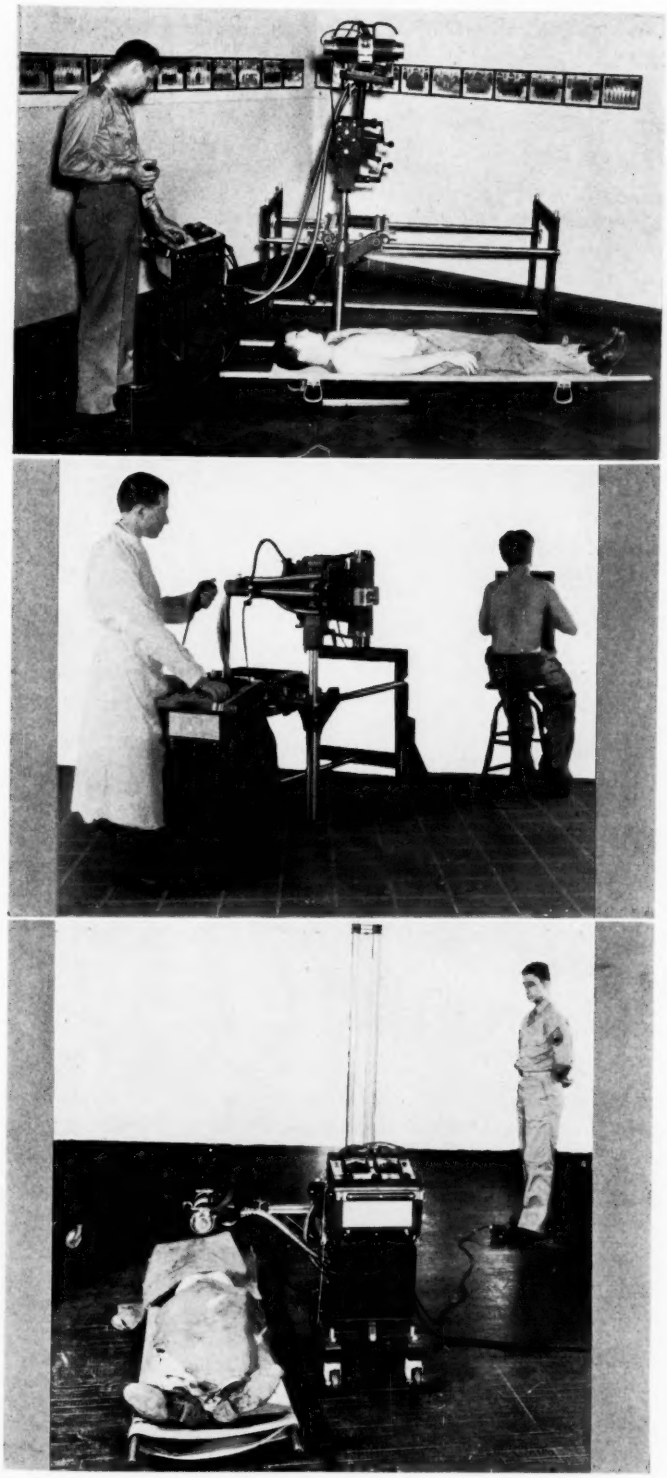




D.

Fig. 4.—Adaptations of the x-ray machine unit. *A*, The set-up with the field table with arrangement of the tube and fluoroscopic screen for horizontal roentgenoscopy and for foreign-body localization; *B*, the arrangement for sitting fluoroscopy; *C*, the arrangement for standing fluoroscopy; *D*, over the table roentgenography; *E*, horizontal roentgenography with long focal film distance; *F*, vertical roentgenography with long focal film distance; *G*, adaptation of the x-ray machine unit to the chassis unit for mobile roentgenography or roentgenotherapy.



E.

F.

G.

Fig. 4.

depending upon the experience of the roentgenoscopist. For precision, though, it is necessary that one be alert to conditions which might result in errors and that he be understanding of the means of correcting such. With each disassemblage and with each assemblage of the equipment following packing and transportation, at least minor damage, such as stripping of threads, perhaps bowing of the localization scale or bending of the depth marker, warping of the roentgenoscopic screen, etc., can be expected to occur. Unless the roentgenologist is constantly alert, such defects will lead to not one or a few mistakes but to a continuous repetition of mistakes.

A small depth phantom has been provided, this being supplied for the purpose of preliminary checking of the accuracy of the localization. Moreover, an adjustment means is incorporated into the supporting arm of the roentgenoscopic screen to correct for variations in focal-spot-roentgenoscopic screen distance due to abnormal positions of the focal spot itself. Adjustment of the reading level concerned with the depth scale has also been provided. This latter provides for cancellation of errors which would otherwise occur due to warpage or corrugation of the roentgenoscopic screen or to tangential viewing by one or another roentgenoscopist with resultant parallax. In short, provisions have been made to compensate for those variables which are beyond the scope of control by the manufacturers. These provisions theoretically mean absolute accuracy. Nevertheless, the degree of accuracy is dependent upon knowledge of the fundamentals, together with the integrity and scruple of the roentgenoscopist.

This general procedure of foreign body localization has been considered adequate to handle foreign bodies in all locations other than in the eye. For localization of intraocular foreign bodies, the "Sweet method," such as used in World War I, still appears to be the most practical. This method requires the use of film. Therefore, such localizations cannot be expected in the very forward zone. They will be accomplished in the more fixed types of evacuation hospitals and general hospitals, where films and processing equipment are available. This particular method is well known to roentgenologists in civil life. Detailed description of it, as well as explanation of the roentgenoscopic procedure, is published in the *Technical Manual 8-275*[3] and elsewhere.[4]

In the very forward installations, such as the surgical hospital, the roentgenologist is the sole diagnostician. In the motorized evacuation hospital, he is one of four diagnosticians. Internists and collaborative consultants are included with installations located farther to the rear. However, due to the requirement of having to arrive at quick decisions and, of having to handle so many hundred cases each day, the roentgenologist may be rated as one of the most useful consultants. He must be capable scientifically, and he must also be very ethical in dealing with his confreres. He must be a coordinator. The attitude of *service* must dominate his actions.

His coordinating spirit must not be limited to his own relations with respect to his doctor confreres. He must be able to command men. In certain locations, he may have only three technical assistants; in others, as many as ten or twelve. Under conditions of warfare, the doctor, the officer, and the enlisted personnel must work shoulder to shoulder. Nevertheless, the enlisted personnel must not be leaned upon too strongly. The roentgenologist must conservatively control the group.

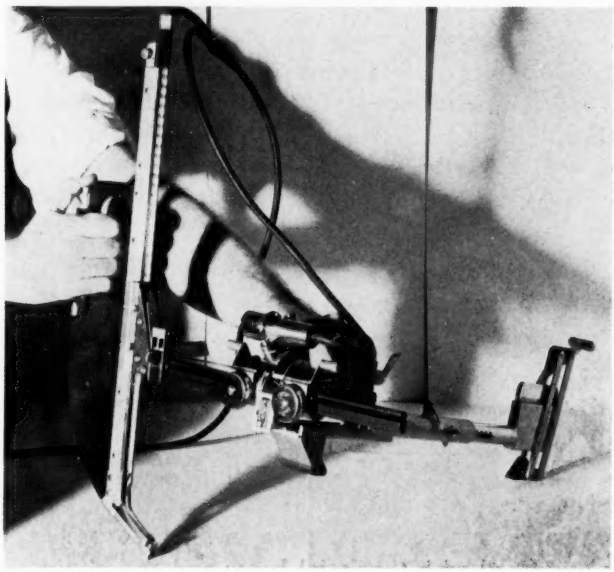


Fig. 5.—The biplane marker. The operator is about to fix this device to the roentgenoscopic screen. Marking in the second plane is accomplished without any x-radiation exposure. Note the pilot lights and cables, provided for manipulating this apparatus without losing accommodation of the darkroom.

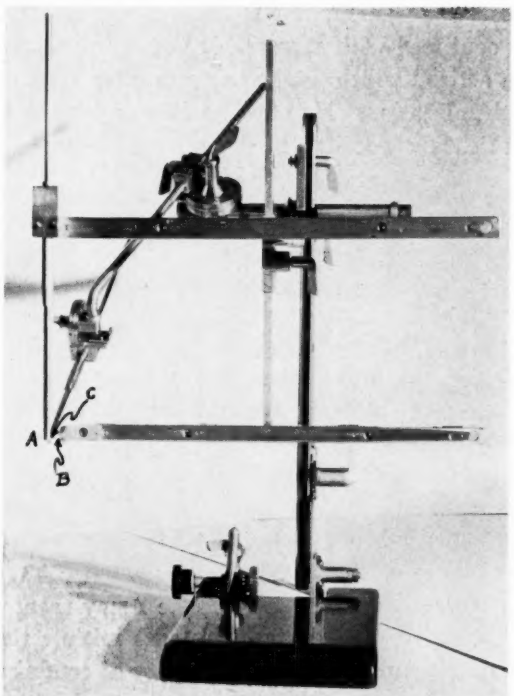


Fig. 6.—The reorientating device. Note the three pointers: *A*, Concerned with the spotting as accomplished with the roentgenoscopic procedure; *B*, that concerned with the spotting as accomplished with the biplane marker; and *C*, the indicator concerned with any selected surgical approach.

As mentioned in the beginning, the diagnostic responsibilities are almost of as great a scope as those with which the civilian roentgenologist has to deal. There will be need for roentgenoscopy of the extremities, with interest as to soft tissue wounds—possibly with interest as to gas bacillus infections. There will be problems relative to fractures; these under conditions of fixation with splints or plaster casts. There will be problems pertaining to wounds in the abdomen and thorax, and there will be problems concerned with a gamut of pathologic conditions besides those of trauma for any of these parts. True enough, similar diagnostic problems are experienced by a well-practiced roentgenologist in civil life. However, in Army roentgenology it can be expected that roentgenoscopy will have to be emphasized over roentgenography. Resort to films requires more time than can be expected to be allowable during stress of activities such as are to be expected in the theater of operations. The roentgenologist must have developed a very keenly discerning eye. Of all phases of roentgenology, it would seem that the field of maxillofacial abnormalities must prompt his particular study and proficiency. Tank and air service casualties, as well as those concerned with ordinary motor transportation, must be expected. There are so many contours concerned with the facial bones and the cranium itself that distinct visualization of any one portion of the head is a difficult task under any conditions. The Army roentgenologist must be thoroughly understanding of all of these contours and of the several positionings concerned with most adequately visualizing one or another portion. He must have a knowledge of anatomic weak sites. He must be equipped with a knowledge of the physiology concerned with the various muscle actions which might serve to alter relations in case of fracture in one or another location. He must be able to discern roentgenoscopically these conditions which are admittedly difficult of diagnosis even with the assistance of films.

The Army roentgenologist must be acquainted with the normal procedures which pertain to procurement of x-ray equipment and materials and, thereafter, their proper handling. With most civilian institutional connections, the roentgenologist may sense merely a moral responsibility for protection of the equipment in his department. Unless he has actually purchased it, paying from his own resources, it is very natural that he should consider it the property of the institution, and it is very unlikely that unserviceability of any part of the apparatus would result in any financial loss to the doctor. Not so in the case of the Army roentgenologist! Though the equipment belongs to the United States Army, it is necessary that it be entrusted to a responsible person, an officer. In case proper accounting cannot be made for unserviceabilities or losses, a depreciated value of the equipment may be deducted from his pay.

Except during periods of actual combat, the Army roentgenologist must anticipate equipment and property needs. He must initiate the requisitioning of these. In this regard, he must realize the necessity of confining his wants, as far as possible, to a list of items considered most practical by our Supply Department. These items are contained in the supply catalog, which is ordinarily in the possession of the medical supply officer. The listing is of "standard items." A supply of such items is usually maintained at a near-by depot. Standard items

are listed according to classes. There are nine such classes. The classification has been made on the basis of general purposes or the type of the commodity.

The roentgenologist is mainly concerned with Class 6 or Class 9, insofar as x-ray equipments might be needed. Class 6 contains a listing of standard x-ray equipment such as might be needed for general hospitals and peacetime installations. Class 9 contains a similar listing of equipment which might be needed for installations such as the mobile surgical hospital or the evacuation hospital; installations operating in the theater of operations. Processing chemicals, such as would be needed for roentgenography, are contained in Class 1. For police and maintenance of a clinic, such as might be concerned with a fixed evacuation hospital or a general hospital, including furniture, cleaning items, stationery, miscellaneous office equipment and linens, are all listed under Class 7.

Nonstandard items are always more difficult to obtain, though where especially needed they can usually be obtained. They are not described in the supply catalog. Spare parts and replacements may be listed, though in many instances they, too, must be purchased as nonstandard items.

Items are carried as expendable or as nonexpendable. Furthermore, they may be identified as deteriorating or nondeteriorating. The roentgenologist must appreciate these characteristics and supervise the care and handling of this equipment as scrupulously as possible. In order to provide for efficiency in handling purchases and unit requisitions, it is necessary for him to understand the problems of the medical supply officer and to anticipate his needs so as to provide for including his requisitions as far as possible at prearranged times.

Except for expendable supplies, a central record is kept of all items issued. The roentgenologist is given a copy of the list for which he is responsible. It is important to inventory the property records and to identify each item when packing for a change of location, when reassembling and otherwise, at least once each month.

Illegal sales have been made of all types of Government property, but in particular, "consumption" of x-ray films must be watched. It is advisable that films be stored within a locked cabinet or a locked room, and that the keys to such be held by one person in the department. A tabulated record of quantities received versus quantities removed from this storage should be posted within this cabinet or room. This record should include the date, the film size, and the quantity concerned with each increment and with each issue, together with the initials of the person receiving them. This record need not be elaborate but it should be complete.

In larger x-ray clinics, besides keeping a record of all films received and all films issued, it is advisable that each roentgenographic technician and also those concerned with processing in the darkroom be required to report the total number of films used or handled each day or each week, as well as the number of films wasted. This system provides for checking the reports of the individual roentgenographic technicians with the summation report by the technician or technicians in the processing room, and both reports with the records contained in the film cabinet or film storage room. Usually, the psychologic effect of such a system will counteract any inclination toward "bootlegging" of x-ray films.

There is a similar temptation for certain people to enter into illegal sales of intensifying screens. These screens are very expensive. They can easily be removed from cassettes, and secondhand screens or blank cardboards may be used for substitutions. Because of such practices, it is advisable to identify each screen with the words: "Property of the United States Government." This description might be written with indelible ink along a margin of the screen whereby the wording will not be reproduced onto useful portions of the roentgenogram. If these captionings are accomplished in the handwriting of the radiologist, there will be provided a definite challenge in case roentgenograms are found in the department which do not bear his handwriting, even though it be evident that such roentgenograms were obtained with the use of cassettes.

These responsibilities pertain, in a general way, to all Army roentgenologists. Whereas one day he may be assigned to a task requiring knowledge in one phase of roentgenology, at another time he can expect a different or more comprehensive assignment. Anticipation of duty in the field of combat should be in the minds of all. In a previous paper[2] the responsibilities of the roentgenologist were considered in terms of the home communities versus the anticipated duties in the theater of operations. Preliminary work has been essentially concerned with chest examinations.[5] This phase, too, is subspecialized to the extent of having to deal with miniature films and with hundreds of studies each day—mass survey studies—and being guided by regulations with respect to acceptable versus unacceptable findings. Most of this work has been concerned with chest roentgenology—known to qualified roentgenologists and phthisiologists. The plan of this phase has been so well crystallized that detailed description of it would seem to be unimportant at this time. It must be realized, however, that these activities are continuing, and they must be expected again on a very large scale at a time of demobilization following completion of the gigantic task in which we are now involved.

SUMMARY

In general, it is realized that "roentgenology is roentgenology whether it be practiced in the Army or out of the Army." The Army roentgenologist is spared certain responsibilities, such as those concerned with obstetrics, gynecology, and to a large extent, those concerned with children's diseases and radiation therapy of malignancies. However, these exemptions are more than compensated by a number of requirements such as exceptional ingenuity, an ability to command men, and very diplomatically coordinate the roentgenologic service; particular acuity of diagnostic ability by way of roentgenoscopy without requiring film studies; familiarity with foreign-body localizations and familiarity with requisitioning and handling of equipment and supplies.

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EFFECTS OF MODERN WARFARE ON CIVIL POPULATION

Experience of Great Britain*

D. Denny-Brown, M.B., F.R.C.P.

TO BEGIN with I shall outline some general aspects of air bombing and procedures taken by the civil authorities, such as evacuation and provision of shelters, because these affect the type and kind of nervous casualties from air raids. Indeed, prophylaxis is more important than treatment.

It was anticipated that any densely populated area which was subjected to military bombing would be the scene of mass panic and mass hysterical phenomena, as well as mass destruction. Yet, bombing of civilian population has failed to produce any sort of mass panic or nervous manifestations. That was first evident in Barcelona during the Spanish War, where the population settled down to a daily routine of their occupations for months of severe bombing. We have very little direct information of the effects in China or Warsaw or in Rotterdam, but there is certainly no report of such mass nervous reaction. There has been nothing of the sort in London or Coventry or any of the other British cities that have been intensely bombed. I think the chief reason is that the population is prepared by earlier, milder experience. If the Luftwaffe had taken the opportunity to bomb London on the very first day after war was declared and had caught a densely populated area at a time when nervous tension was at its height, the tale might have been different. But, in actual fact, there was sufficient warning, it was always obvious that things were getting worse, and nearly always people have experienced bombs at a distance before they have experience of bombs close by. Possibly most of those who feel they cannot go on with it manage to get away somewhere where bombing is not so intense.

The destructive effect of a bomb dropped from the air is extraordinarily limited. In the towns that have been bombed, you will see a house missing here, a shop missing there, or a large hole in the street. Houses on either side are battered by flying masonry but are not blown down. Within a radius of twenty or thirty yards there is utter destruction, and beyond that things are left standing. Within quite a much wider radius all glass, windowpanes, and often door frames, are broken by the blast of the explosion. Under those circumstances it is, therefore, fairly obvious that though a shelter of any sort has to be very strongly built, and if possible, to be deeply built in order to escape the effects of a direct hit, there are relatively very few chances of such a hit. A deep underground shelter is about the only place that is safe from a direct hit, but underground shelters are very expensive to build. It is impossible to build sufficient deep shelters for the whole population of a city. It would virtually be another city under the ground. Further, even deep shelters have

*Lecture XXIII, reprinted from *Collected Lectures*, the Metropolitan State Hospital, Waltham, Mass., 1942.

disadvantages in that occasionally an explosion near by will fracture deep water and gas conduits, and so bring danger of drowning or poisoning to the occupants. Many nervous people will literally spend all their time in deep shelters if they can. They are better evacuated from the area. It is more satisfactory to have people scattered as much as possible rather than have them all together in one place. The ordinary person is accordingly encouraged to take shelter in basements under or near his own home or near his place of work rather than to seek some large public shelter. A percentage of bombs dropped indiscriminately fall not in buildings but in streets, yards, and other spaces, even in a city. Any modern steel-frame building offers fair protection. Bombing of towns in broad daylight in the face of an air force that has any real strength has proved to be too expensive for the air force concerned, so that it is mainly a nocturnal experience. Shelters should be warmed, should be provided with some sort of sleeping accommodations, bunks, and they should be provided with adequate sanitation, and, if possible, with some first-aid arrangements.

While many people will take shelter, there is much to be done on the surface. The most efficient weapon of an air force seeking to destroy industry or communications is the incendiary bomb. Thousands of these bombs can be dropped rapidly in a small area, and twenty minutes later, when a few fires have started, another group of bombers can drop more high explosives and more incendiaries. If the incendiaries are extinguished, the damage is minimized and the bombers do not see their targets. It is essential to have large numbers of the population on the watch for them, on every roof with sand and spray pump to extinguish them rapidly wherever they fall. For this reason, in every area likely to be bombed the population has much to do besides take shelter. Clerks, bus drivers, professional men and women, all except children, have to take turns in fire-watching homes, industries, offices. Thus people are as widely dispersed as possible in any underground shelter or basement, and many others are fire-watching. In addition there is the ordinary force of civil air-raid wardens, ambulance and first-aid posts, and accessory fire tenders manned by part-time and full-time personnel, as well as the regular municipal hospital and fire services. One-third of the population is engaged in some form of "air-raid defense." In such a scattered and occupied population the casualty rate in one heavy night bombing in a place of 100,000 population would be approximately 250 to 500 people injured in the raid, depending upon its intensity.

A number of problems arise from this sort of organization. An air raid is a terrifying happening, but the effects are minimized by good organization. Hospital services are scattered as much as possible. Emergency light and other services are prepared. The sorting of casualties is arranged so that someone responsible sees every casualty on arrival and immediately attaches an appropriate label. The most important category is shock, because many patients with multiple injuries are dug out and are found to be severely shocked on arrival to the hospital. All patients referred with purely nervous symptoms are segregated. The responsibility on those who segregate the patient is high, for they should be able to distinguish shock and hysteria, be immediately able

to direct the excitable patient or the patient who is simply mute, or the patient who is in a state of stupor, to a place where he can be dealt with separately. It must not be forgotten that occasionally patients who are in a state of stupor may get very cold and shocked, even though they actually may not suffer any particular bodily injury. For many patients a hot drink and a sedative are sufficient. The most useful drugs are bromide and chloral, a mixture of 30 grains of bromide with 20 grains of chloral, but occasionally morphine is used. From 50 to 75 per cent of the patients suffering from nervous conditions during air raids will be ready to go home after having hot coffee and a sedative and after having been allowed to rest or sleep until morning. The remainder are admitted the next day to a subsidiary hospital outside the town. A large building in the country, a big school, or more often a mental hospital, part of which has been evacuated so that three of five or six wings would be used for the reception of casualties, is used.

With this sort of scheme, the original large city hospital is arranged to accommodate perhaps only 150 patients as a casualty hospital. In between air raids the normal population still attends out-patient clinics of the original hospital, and patients requiring hospital admission are admitted not to the parent hospital but to one of the rural subsidiaries. The arrangements are always such that the subsidiary keeps about three-quarters of the beds prepared for casualties. This system has never at any time been overstrained. In fact, there are many critics who say it is too elaborate. However, it is very possible that air raids will be more frightful still, since so far all belligerents have been spared the horrors of gas warfare.

The general procedure with nervous and psychiatric casualties is to move all who have not recovered in four to six weeks to special hospitals for such cases. It has been found necessary in London to have only two hospitals devoted entirely to nervous disorders, and neither of these has ever been completely filled. It has never happened that such a large number of strictly nervous casualties has occurred in any one place that they should have to be admitted direct to any particular hospital for nervous disorders. There were at the beginning at least three other special hospitals set up for nervous casualties, but these were long since disbanded. Most nervous casualties recover rapidly. By far the most common type of nervous casualty is stupor or hysterical fugue. When bombing goes on night after night for two weeks or more, a number of people break down, but usually before this condition occurs they are persuaded to go to the country for a one or two night rest, and are aided by some organization set up for the purpose. Everyone feels it is his or her duty to stay, so that some intelligent supervision is necessary to make the best of such arrangements. What most people need very badly is sleep, and a good organization will arrange beforehand to send everybody in rotation away from the city for two days with friends or billets in the country. They sleep solidly for the first twenty-four hours, then relax for another day and are ready to go back again.

Transient conditions of exhaustion, with anxiety symptoms and depression of various degrees, and fugues are extremely common. There are different kinds of dissociated state. In some the condition is very superficial, and the amnesia is recalled with only slight assistance. In others it is deeper and some

assistance by suggestion or hypnosis is required. I think it is essential to recover the amnesia in most cases. In still other cases the dissociated state or fugue is only one aspect of what is very much deeper emotional depression, and even if you succeed in clearing the fugue, a depressed state with retardation, often some depersonalization, remains. The illness has then a certain momentum which will take several weeks, perhaps five or six months, to overcome. Such patients must be dealt with in special hospitals with such treatments as continuous narcosis, which in my experience has been most satisfactory, except that it does require very skillful nursing and personnel. Convulsive therapy is little used for such cases.

It is difficult to get any statistics, for psychiatric casualties are mixed up with all others at the start, and are moved so rapidly and so far. No doubt official figures will be available in time. But I can say that from very large cities, such as London, the scale of *persistent* disability is very little more than the rate of peacetime nervous illness (their population being now much lower through evacuation of women, children, and some industries to the country).

Those dealing with psychiatric casualties have found, just as those dealing with psychiatric conditions in the Army and other services have found, that it is the person who has had constitutional history and previous bad personal history who is liable to break down. If you select those patients who have not recovered after six weeks, the proportion of them who have either bad family history, or history of previous breakdown, or both, is very high indeed, sometimes over 90 per cent. So it is the peacetime psychoneurotics that turn up under war conditions with breakdowns. People can adapt themselves to all conditions. If breakdown does occur, it has a natural tendency to recovery. Certainly I am sure young children are affected very much less than adults. Children up to the age of 3 or 4 do not appear to realize what is going on. I have seen nervous children between the ages of 6 and 12 years with tics, enuresis, troubled sleep, screaming attacks, tantrums, etc., if they are upset by an air raid, but most of them settle down very quickly. A very small percentage of children suffer from persistent nervous conditions, and these are usually constitutionally nervous children. In some all this disturbance of ordinary life is a help to psychoneurosis. Some chronic neurotics of peacetime now drive ambulances or fire tenders and complain no longer of their nervous symptoms. The more simple anxiety state, if there is something really worth while to get on with, can be really benefited by all this organization and feeling of urgency. If a breakdown occurs, it will, of course, be more severe. But the herd instinct can have beneficial effects, and the rejuvenation of the chronic psychoneurotic is one of them.

Apart from the direct effects of the air raid, there are other problems related to evacuation. It is important in densely populated areas to try to get everybody who is not occupied in essential work out to some other place, to move industry, and women and children from the densely populated areas to country areas where bombing is either not likely or not dangerous. Communications are not always good, and the wife with her children in the country soon gets worried as to what has happened to her husband in town. In England all evacuation is purely voluntary. The government pays the expenses of moving the family to the country, but, of course, the wage earner still has to pay the rent for his

apartment or house in town, and he has to contribute to the upkeep of the family in the country. There is a much greater stress on the family budget. Such anxieties can in part be dealt with by a good social service organization. A framework of experienced social service workers can function very efficiently if sufficient voluntary help is available from women's societies. A small bureau is established in every town and village for evacuated people, managed usually by one paid secretary and a number of volunteer workers, and is called the Citizens' Advice Bureau. Advice is given on all problems, communication with relatives, notification of casualties, procedure in relation to paying rents and claims for damages. Such an organization is an excellent prophylactic for psychoneurosis.

THE CHEMOTHERAPY OF BACILLARY DYSENTERY*

Further Observations on Sulfaguanidine

Commander George M. Lyon, M.C., U. S. N. R.

THE use of sulfaguanidine in the treatment of acute bacillary dysentery has been described in a report[1] based on the study of a small series of patients having the disease in a severe or moderately severe form. In this study alternate patients were treated with the chemical while others, as controls, were not. Since that time sulfaguanidine, the guanidine analogue of sulfapyridine, has had extensive practical application in the management of patients with "bloody flux" in the offices, homes, and hospitals of an area wherein bacillary dysentery is an important disease. An unusual opportunity for this study was presented by the occurrence, during this time, of what was probably, in the counties concerned, the highest incidence of the disease since 1926. More than 300 patients with "bloody flux" were treated with sulfaguanidine. Their records permit an appraisal of the effectiveness, and the suitability of this chemical agent for general practice in the treatment of acute bacillary dysentery, not only in the hospital, but of perhaps even more practical importance, in the offices and homes as well. A more detailed analysis of these records has already been presented.[2-4]

With few exceptions the method of administration employed was that originally recommended by Marshall[5] and employed in the previous clinical study.[1] The initial dose was 0.1 gram per kilogram of body weight, while the maintenance dose was 0.05 gram per kilogram of body weight administered orally every 4 hours until the stools were less than 5 in 24 hours, and then 0.05 grams per kilogram of body weight every 8 hours for 48 to 72 hours. That an adequate urinary output should be maintained, had been stressed repeatedly and in general was well observed. Particular attention was paid to the detection of any untoward effects which might result from the administration of the relatively new chemical.

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From this experience certain impressions have been gained in addition to which there are some more definite conclusions which may be drawn, and it is, therefore, possible now to present further recommendations in regard to the clinical use of the drug.

Sulfaguanidine proved to be an effective therapeutic agent in the treatment of acute bacillary dysentery. When used in the manner described, and when treatment was begun during the first 5 days of illness, recovery usually occurred in 2 to 5 days. In the majority of instances, 5 days of chemotherapy was all that was required. When so used sulfaguanidine was entirely free from toxic effects. This freedom of dangers from toxic effects is in striking contrast to that of the other sulfonamide compounds, one of which, sulfathiazole, is described as being quite as effective as sulfaguanidine in the treatment of acute bacillary dysentery and which indeed may be more effective than sulfaguanidine in the treatment of the diarrheas resulting from parenteral infections.[6, 7]

As previously stated, when chemotherapy was begun within 5 days of the onset of fever or diarrhea, and when employed in the manner described, recovery almost invariably followed in 2 to 5 days. When not employed until later in the disease, results were frequently amazingly good, but failures were encountered somewhat more frequently. When treatment with the drug was begun after the fifth day and before the eleventh day, results, as a rule, were better than when begun after the eleventh day, but not as good as during the first 5 days. The importance of early treatment cannot be overemphasized.

When there was blood and pus in the stools and when there was fever present, even though the treatments were not begun early in the disease, results were nearly always as satisfactory as in the patients treated earlier. When, however, the dysentery bacilli had disappeared, and when there was no blood or pus in the stools; when the stage of bacterial activity was past and the stool was of the green watery type (so characteristic of the frequently encountered "post-infection" intestinal indigestion), sulfaguanidine had the least beneficial effects. This is to be expected, however, in view of the underlying pathology.

It is an outstanding characteristic of acute bacillary dysentery, although one frequently overlooked, that with remarkable frequency the stage of active bacterial infection is followed by an impaired ability on the part of the intestinal tract to digest and to assimilate food. It is generally accepted that this occurs as a result of the damage produced within the gastrointestinal tract by the dysentery bacilli, or their toxins. This form of "post-infection" intestinal indigestion was formerly very common among infants and young children, and is not infrequent today in those dysentery patients not receiving chemotherapy. Although less common in adults, this sequela is not at all an infrequent one. Since this condition results from damage done to the intestinal tract by the bacilli themselves, or by toxins produced by them, and since the bacilli by this time have usually left the intestinal tract, or have been supplanted by secondary invaders, one cannot expect sulfaguanidine to be such an effective agent in clearing up this diarrheal state. In actual practice it did not do so.

Sulfathiazole is said to be effective in those cases where the continued diarrhea is the result of secondary invaders, with or without deep ulceration. On

theoretical grounds there is indeed much to recommend it, or sulfadiazine, in such instances, and either may be more effective than sulfaguanidine. Fortunately, such conditions are not commonly encountered and practically never occur if chemotherapy is instituted early in the infection. Occasional cases of diarrhea were encountered which appeared to be simple watery diarrhea, without significant bacterial infection, without blood and pus in the stools, and which, despite adequate chemotherapy, did not yield to either sulfaguanidine or sulfathiazole. In such cases the diarrhea may possibly have been due to:

1. A previously undetected acute bacillary dysentery with the subsequent development of the "post-infection" intestinal indigestion already described.
2. A parenteral infection not discovered.
3. A diarrhea due to a local or systemic virus infection.

In general, the best results with sulfaguanidine were obtained in those patients treated earliest after onset, who were most ill, and who had blood and pus in their diarrheal stools at the time chemotherapy was begun. It was least effective in those in whom treatment was not started until after the acute bacterial invasion was over, when the stools were simply green, watery, and without blood, pus, or dysentery bacilli.

Sulfaguanidine appears to be equally effective against all of the various strains of dysentery bacilli. Paradoxical as it may seem, it has appeared to have its most striking effect in the treatment of the toxic Flexner and Shiga strains. Two instances of Shiga were added and the results were the same as with Flexner. This has since been amply confirmed by Hardy and others. There is some limited evidence to suggest it was somewhat less effective against the clinically less toxic Sonne strain, one which so frequently gives rise to mild afebrile diarrhea without blood in the stools and often with little pus.

Most of the toxic effects which have been observed in the use of the other sulfonamides have also occurred following the use of sulfaguanidine. Such have, however, occurred almost invariably when the drug had been given in doses larger than recommended by Marshall and doses that were larger than those employed in the present study, and when, likewise, due regard was *not* paid to the importance of the frequency and the character of the stools, and to the relationship this has to the concentration of the drug in the intestinal tract when the stools are infrequent. Such toxic effects can be avoided almost entirely by employing the drug as recommended originally by Marshall, provided there is meanwhile an adequate urinary output, which definitely enhances the likelihood of there being no toxic effects. An adequate urinary output is always a desideratum in the treatment of acute bacillary dysentery. The fact that treatment is usually terminated in 5 to 7 days is an added safeguard against toxic effects. Toxic effects may have been encountered somewhat more frequently in adults than in infants or young children where they they were almost entirely missing.

Although sulfaguanidine was least effective after the first 5 to 10 days of illness, and after the blood and pus in the stools had given way to the plain watery stool which contained no dysentery bacilli, there is sufficient evidence at hand to indicate the desirability for the use of sulfaguanidine in all suspected cases of bacillary dysentery, "flux," or "infectious diarrhea" with

fever. It should be given for 5 to 7 days and thereafter if recovery has not occurred it may be best to give sulfathiazole, or still better, perhaps sulfadiazine, for another 5 to 7 days. In the meantime, strict regard must be paid to the urinary output, for with all of the sulfonamide compounds there is a strict relationship between adequate urinary output and freedom from toxicity. This is particularly to be remembered in the use of sulfathiazole and sulfadiazine.

Where there are obvious or suspected infections outside the gastrointestinal tract, it may be desirable, at the onset, to use sulfathiazole, or sulfadiazine, in the place of sulfaguanidine. While in such instances this practice may perhaps be more effective, in the experience described, it was never necessary to resort to it in the early stages of the acute infection. Also it presented no strikingly favorable results in the treatment of those cases with such complications observed 10 or more days after the onset of diarrhea.

Although potentially carrying a greater risk of toxicity, both sulfathiazole and sulfadiazine have been shown to be effective in the acute stages of bacillary dysentery. Because of their greater tendency to produce toxic effects, and because of the greater care with which they must be given, it would seem that they should be the drugs of secondary choice in the treatment of acute bacillary dysentery in the early stages. In the later stages, or in the state of "post-infection" intestinal indigestion, their use may be more strongly indicated. For use in the home, office, or dispensary they are definitely not so safe as sulfaguanidine, and should not be employed as sulfaguanidine may be. One of the most satisfactory features of sulfaguanidine is the large margin of safety permitted in this respect without sacrificing therapeutic efficacy. It is necessary, frequently, to treat cases of acute bacillary dysentery without the benefit of hospitalization. For them sulfaguanidine is distinctly the drug of choice. Experience has proved that good results have followed this practice.

Excepting newborn, no deaths occurred among the patients treated with sulfaguanidine, provided treatment was begun during the first 5 days of illness (diarrhea and fever) and such cases did not have other important infection outside the intestinal tract. Parenteral infections, whether due to a virus of the influenza type, or to pyogenic bacteria, were observed to exert a detrimental influence on the clinical progress of the patient with bacillary dysentery just as they have on other diarrheal states. It is not logical to expect that such parenteral infections would yield to sulfaguanidine therapy. On the other hand, it was observed, more frequently than not, that under the influence of the drug, the stools became normal promptly and the intestinal tract appeared better able to carry out its work.

In the latter stages of acute bacillary dysentery or its sequela, it may be impossible to determine which of the difficulties encountered are due to a continuation of the primary bacterial invasion, to secondary invaders of the intestinal tract, to parenteral infection, or to damages within the intestinal tract due to the primary bacterial invasion. This complicates the problem of appraising the effectiveness of any chemotherapeutic agent used in acute bacillary dysentery or other diarrheal states.

No persistent states of "post-infection" intestinal indigestion developed in any of the patients in whom chemotherapy was started within 5 days of the onset of fever or diarrhea.

Those cases receiving the chemical early showed surprisingly little disturbance of digestion either during the period of active therapy or following recovery. In spite of this, however, it has seemed advisable to employ a bland diet, moderately restricted in amount, during the period of active treatment. There is some reason, based upon careful observation, to believe that those patients who were on a diet which was high in protein (casein), and which was moderately restricted in amount, presented the best and most prompt recoveries. Cultured lactic acid milk, cottage cheese, Philadelphia cream cheese, and custard, when given in moderate amounts, seemed to be the diet of choice. Vitamins, in powder form, were added to the cultured lactic acid milk and may, or may not, have influenced the recoveries.

Sulfaguanidine was most effective during the time when the dysentery bacilli were more active. It was least effective when the activity of these bacteria was absent and when their residua remained within the intestinal tract in the form of abnormal physiologic states. While the chemical effectively controlled the activity of the bacteria, it did not, by itself, correct damages already produced by the bacteria, or their toxins, once such damage was already established. By controlling the bacterial infection, sulfaguanidine may have aided such supportive measures as adequate fluid intake, intravenous glucose, calcium gluconate, transfusions of serum or whole blood, etc., so that they might, more effectively, correct attendant chemical pathology. It should be emphasized that sulfaguanidine did not and will not overcome acidosis, dehydration, fluid imbalance, or electrolyte disturbance.

When altered physiologic states, or those characterized by unusual chemical pathology, were already present before the institution of chemotherapy, it was necessary to employ measures directed toward these specific conditions. In the more protracted forms, and in the absence of such special measures, chemotherapy would undoubtedly have been much less effective.

Sulfaguanidine was not as effective in recurrent attacks of bacillary dysentery, nor in the more chronic forms, as it was when used within 5 days after the onset of the original attack. If, on the other hand, the stools contained blood or pus, and there were dysentery bacilli in the stools as shown by culture, the results were generally very good. It was difficult to predict what the result would be. At times, so striking and so prompt were the beneficial effects of the drug, in these forms of bacillary dysentery, that one cannot escape the conviction that sulfaguanidine should be administered in all forms of bacillary dysentery for at least 5 to 7 days in the manner recommended. If at the end of that time recovery is not apparent, then sulfathiazole or sulfadiazine should be given for 5 to 7 days. Some of the most amazing results so far encountered in the use of sulfaguanidine occurred in stubborn, serious cases of chronic bacillary dysentery.

Relapses, whether early or delayed, were extremely rare after the use of sulfaguanidine in the treatment of acute bacillary dysentery. Certainly this was in striking contrast to the frequency with which such conditions occurred in those who did not receive chemotherapy.

There was no reason to believe, either from the bacteriologic or from the epidemiologic standpoint, that the use of sulfaguanidine tended to "mask" infections of dysentery bacilli, or to complicate the community health situation by increasing the "carrier" rate.

In homes where outbreaks resembling the institution type of outbreak of bacillary dysentery occurred, it was possible, with sulfaguanidine, to control promptly and effectively, not only the individual cases, but also the spread of the outbreak as well. The chemical has great value as a control agent in outbreaks occurring among those whose living conditions are crowded, which so frequently are encountered in mining areas, in the poorer districts, and even in military camps and establishments. It is possible in an institution to check such an outbreak within a few days by giving everyone in the institution the chemical for a period of 5 to 7 days. It must be remembered that in so doing the maintenance dose should be employed and given only every 8 hours if the stools are less than 5 a day as they are apt to be in those not already stricken with the malady.

Sulfaguanidine is of definite value in reducing the number of days of illness due to bacillary dysentery. This gives it unusual importance in industrial and military medicine. Its wider use will result in a continuously lower dysentery mortality rate.

Early recognition and early treatment are just as important in the treatment of bacillary dysentery as the antibacterial activity of the chemical itself. Best results were definitely attained when chemotherapy was applied early in the disease.

Sulfaguanidine is quite as effective in the treatment of acute bacillary dysentery in adults as it is in infants and young children.

Chemotherapy has completely revolutionized the treatment of bacillary dysentery. Sulfaguanidine is quite as effective in the treatment of acute bacillary dysentery as sulfanilamide is in the treatment of some streptococcal infections or as the other sulfonamide compounds are in the pneumococcal infections. Besides its therapeutic effectiveness, the chemical is easy to give and has such a wide margin of safety that it is the ideal agent to use in the treatment of bacillary dysentery.

NOTE.—Since submitting this report, it has been possible to observe the treatment of 14 patients with severe or moderately severe bacillary dysentery, who were treated with succinyl sulfathiazole. In severity and in clinical characteristics these were in all respects similar to those previously described in a controlled study.[1] The initial dose was twice the maintenance dose. This in turn was 0.04 gram per kilogram of body weight every 4 hours if six doses were given daily, or 0.05 gram per kilogram if five doses were given daily at approximately 4-hour intervals. After the diarrhea had been "checked" for 72 hours the drug was discontinued. In this admittedly small series of cases, succinyl sulfathiazole appeared to have all the virtues of sulfaguanidine as to therapeutic efficacy and as to freedom from untoward effects. It was exceedingly well tolerated.—[G. M. L.]

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MEDICAL ILLUSTRATION IN THE UNITED STATES ARMY*

Historical and Present Considerations

Captain Ralph P. Creer,† U. S. Army

IT HAS been said that the only worthwhile result of any war is the great advancement that is produced in medical science. If this is true, then it follows that proper and adequate illustrations of these achievements are important.

Medical illustration in time of war is by no means new. The ancient Greeks and Romans produced illustrations of a medicomilitary nature (Fig. 1). As early as 1497 line drawings appeared in *The Book of Surgery*. One illustration entitled "The Wound Man" shows many types of injuries by various weapons and external agents, such as those acquired from a thorn, an arrow, a club, a knife, a sword, and similar devices (Fig. 2*A*). Another woodcut published in 1528 illustrates the disinfection of a wound by cauterization (Fig. 2*B*). The extraction of an arrow from the cardiac region by military surgeons was also depicted in 1528 (Fig. 2*C*).[2]

The surgical work of Ambroise Paré,[3] famous French surgeon, published in 1634, contains medical drawings. The *Memoirs* of Larrey,[4] surgeon to Napoleon, is illustrated with fine steel engravings of war wounds and instruments.

There are many other examples of early medicomilitary art. However, in the interest of brevity this paper is limited to medical art in the Army of the United States, beginning with the Civil War.

On Nov. 24, 1863 Gen. Joseph K. Barnes, Acting Surgeon of the Army, issued the following Circular Letter No. 26:

> The attention of Medical Officers in charge of U. S. A. General Hospitals is invited to the importance of preparing illustrations of the results of surgical operations. These can in many instances be conveniently obtained by means of plaster casts, which are readily made without subjecting patients to the slightest inconvenience.
>
> The casts most desired are those of stumps of amputations of every variety, and models of limbs upon which excisions may have been performed.

Soon after the War Between the States, *The Medical and Surgical History of the War of the Rebellion*[5] was published. This group of stately volumes gave

*From the Army Medical Museum, Washington, D. C.
†Sanitary Corps.
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a clear visual idea of the type of wounds encountered, the means of surgical repair, and the many traumatic diseases which then as now were problems of all wars.

There were a number of contributors to these well-illustrated books. Of course, the early photomicrographic achievements of Col. J. J. Woodard, Major Curtis, and W. M. Gray are well known to students of photomicrography. William Bell, Charles Throught, and C. J. Blacklidge made most of the clinical and gross pathologic photographs.

The drawings were contributed by Baumgrass, Dr. J. C. McConnell, William Schultze, Edward Stauch, and Hermann Faber. The latter had a distinguished career as an artist. At the outbreak of the Civil War he enlisted and was assigned to the Surgeon General's Office as a medical artist, although rated as a hospital steward. He remained in the Service for five years and after the war returned to Philadelphia, where he continued to practice his profession. Together with his two sons, Ludwig and Erwin, and Louis Schmidt, he illustrated Piersol's *Human Anatomy*[6] and other important texts.

Special mention should also be made of Gen. George M. Sternberg, who served as a medical officer in the Civil War at the age of twenty-three. Bacteriology and photomicrography were his main interests and in his biography published in 1920 by his wife Martha[7] the following statement is found: "After our arrival at Fort Mason, Dr. Sternberg was not long in establishing at his own expense a laboratory for biologic research. It was here in 1881 that he demonstrated and photographed the tubercle bacillus, discovered by Professor Koch earlier in the same year. I am informed on good authority that this was the first demonstration of the organism in America."

He was the author of a textbook entitled *Photomicrographs and How to Make Them*.[8] In 1879 Sternberg published a well-illustrated atlas of photomicrographs. He later became Surgeon General of the United States Army.

Medical illustration in the United States Army received its greatest impetus during World War I. In June, 1917, Mr. Roy Reeve was assigned as photographer at the Army Medical Museum. Almost immediately the need for a more active service was recognized and in less than a year the personnel of this department was increased to approximately twenty. Their duties for the most part consisted of photostat copying, and a number of lantern slides were prepared for teaching purposes. This was the beginning of a permanent photographic department which has contributed ever since to the effective and efficient dissemination of medical knowledge.

In the same year, 1917, a medical art department was organized under the supervision of Lieut. William T. Schwarz and Lieut. M. L. Bauer; a motion picture section under the direction of Lieut. Thomas Evans also was started.[9] The function of the art department is best described in an article by Major R. W. Schufeldt published in July, 1918.[10]

> The scope of the Art Department was, when first put on foot, very modest, being principally confined to the making of a series of drawings and designs for use in motion pictures. Then man after man was added, each skilled in some special line, until at this writing there are first-

class painters in both oil and water colors; anatomical and pathological artists, histological artists, as well as modelers and casters, designers—indeed, technical artisans of nearly every sort known to the professions and trades.

Another field into which the output from this art department finds its way is the instruction of men and officers at the various cantonments and camps, in this country as well as in France. This is accomplished through the scientific use of the motion picture machine and the lantern.

Fig. 1.—The physician Iapyx extracting an arrowhead from the thigh of the wounded Trojan hero Aeneas. From a Pompeiian wall painting.

Competent medical officers, who are good instructors, are sent out on this work, equipped with projecting instrument, screen, and films or slides, and give a complete set of lectures at the camp or cantonment to which they are directed to proceed. This entire scheme has resulted in vastly improving the fitness and health of both officers and men of our army, and the amount of improvement so produced is now being very rapidly increased. Our art department has very substantially aided in this, and its assistance is being felt more and more each day that passes.

Most of the artists assigned were portrait or commercial painters with little or no knowledge of medical illustration. Therefore, a complete dissecting room was provided where these men made actual dissections upon a cadaver under the supervision of a competent anatomist and teacher.

The motion picture department was charged with the responsibility of producing instructive teaching films in relation to health for Army consumption. The original negatives were made by this department and a number of duplicate films were processed by the personnel. The motion picture "Fit to Fight" is an example of the type of film produced by the department; nineteen copies were distributed throughout the Army camps. Other two-reel anatomic pictures relating to veneral diseases were also made.

During the course of and directly following the last war two exceptionally worth-while texts were published. In each instance medical illustrations were of incalculable value.

A Manual of Surgical Anatomy[11] was authorized by the Secretary of War. Supervised by the Surgeon General, this manual was prepared at the University of Illinois and the illustrative work was executed under the direction of Mr. Tom Jones.

In 1920 a book entitled *Studies on Pathology of War Gas Poisoning* was published by Dr. Milton Winternitz. The work was done with the consent of the Surgeon General of the Army and the Chemical Warfare Service. This volume was well illustrated by Mr. Armin Hemberger, a medical artist at the Yale University School of Medicine.

Early in April, 1918, Col. Louis B. Wilson reported to France for duty as Director of the National Army Medical Museum Unit. Soon after his arrival he visualized the need for a competent medical illustration service and in May, 1918, a request was made for clinical photographers and artists who were already on duty at the Army Medical Museum in Washington. This request was disapproved by the general staff "in view of the existing tonnage situation, and in the belief that the requirements could be successfully handled by the Signal or Engineering Corps."

An attempt to locate qualified personnel in these organizations proved futile. Thus, a second request was made to the War Department and finally on Sept. 14, 1918, one officer and seven enlisted men arrived in France prepared to make motion pictures of war wounds and injuries. A few weeks later several medical artists and moulage experts reported for duty and a general illustration unit was established at Vichy in the central hospital laboratory of the Base Hospital Center.

Prior to the arrival of this last group a number of units had brought with them fairly good amateur photographers. However, in many instances these men were put into work entirely foreign to photography and considerable time was lost in effecting their transfer to departments where their photographic ability would be available to the medical service. Furthermore, Colonel Wilson encountered some difficulty in arousing interest in medical motion pictures. Most of the surgeons at that time did not see any value in motion pictures of surgical operations, and this particular branch of medical illustration was not encouraged.

Furthermore, General Orders No. 15, H., A. E. F., Jan. 24, 1918, limited the practice of photography in the American Expeditionary Forces to the Signal Corps. On May 25, 1918, another General Order was issued which amended the previous orders and charged the medical department with making

Abb. 91. Ausbrennen einer Wunde mit einem Glüheisen. Holzschnitt in der Weise Wechtlin's aus: H. v. Gersdorf, Feldtbuch der Wundartzney. Straßburg, Joh. Schott, 1528.

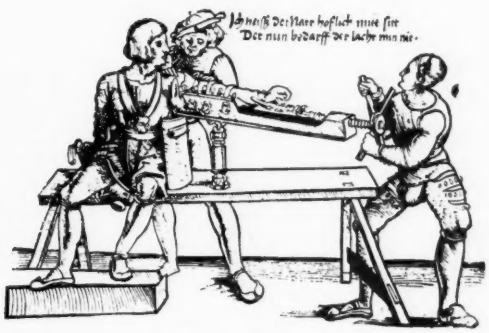

Abb. 89 u. 90. Schenkelstreckung und Armstreckung mittels künstlicher Maschinen. Holzschnitte aus: H. v. Gersdorf, Feldtbuch der Wundartzney. Straßburg, Schott, 1528.

A. *B.* *C.* *D.*

Fig. 2.—*A*, The "wound man" from Hieronymus, 1497. *B*, A woodcut, probably by Wechtlin, showing disinfection of wound by cauterization, 1528. *C*, The extraction of an arrow from the cardiac region by military surgeons, 1528. *D*, Woodcuts illustrating the treatment of fractures of the knee, thigh, and arm, 1528.

technical photographs of surgical and pathologic interest. In order to carry out this responsibility a survey of the medical department was made to ascertain the availability of suitable photographic equipment.

Because of the previous ban on photography by the Medical Department practically no hospitals were found equipped with sufficient apparatus or materials. A few cameras were procured from French sources, three were borrowed from the Signal Corps, and twenty-four from the roentgenologic department of the professional service. When finally equipped this group produced thirty-five casts of surgical cases, about 200 drawings, and more than 1,000 photographs of technical subjects prior to the signing of the armistice of Nov. 11, 1918, approximately three months of actual service.

Although the Signal Corps had been authorized in March, 1918, to illustrate the medical history of the war, they had been able to cover but little of the medical activities of the American Expeditionary Force, except for popular subjects which were used for propaganda purposes. After the signing of the armistice, and as soon as the clinical photographers could be released from their duties with combat divisions, they cooperated with the Signal Corps in illustrating the medical history with still and motion pictures. This bureau made more than 10,000 still pictures and about 40,000 feet of motion pictures of hospital activities, hospital locations, and group and individual pictures of the medical officers of the General Staff.

As a result of his knowledge of the organization difficulties which were encountered during the First World War, Colonel Wilson wrote in the February, 1920, issue of the *Military Surgeon*[13] as follows: "Restrictions on photography, such as operated early in the history of the A. E. F. so greatly to hamper the activities of the Medical Department, would seem to be unnecessary for safeguarding information, the Laboratory Division no doubt being as trustworthy as the Signal Corps. Preparation should be made in peace time for the selection of trained personnel for the various highly specialized functions which must necessarily be performed. Provisions should also be made for a standard photographic equipment to be supplied to the laboratories of various types. Special attention should be paid to photographs of methods of handling the wounded and of the appearance and treatment of battle injuries in forward areas, an adequate knowledge of the conditions of which is so essential and yet so difficult to convey to the inexperienced medical officer."

Similar ideas were suggested and the value of medical illustration in time of war was outlined by the author in a paper presented at the Annual Convention of the Association of Military Surgeons in October, 1938.[14]

At the request of the Surgeon General's Office the Biological Photographic Association in 1940 furnished a list of competent and qualified clinical photographers. Mr. Tom Jones and Mr. Jack Wilson cooperated in supplying a similar list of medical artists.

Early in 1942 Col. J. E. Ash, Curator of the Army Medical Museum, was charged with the responsibility of organizing the "Museum and Medical Arts Service." The purpose of this newly formed unit is to provide an adequate

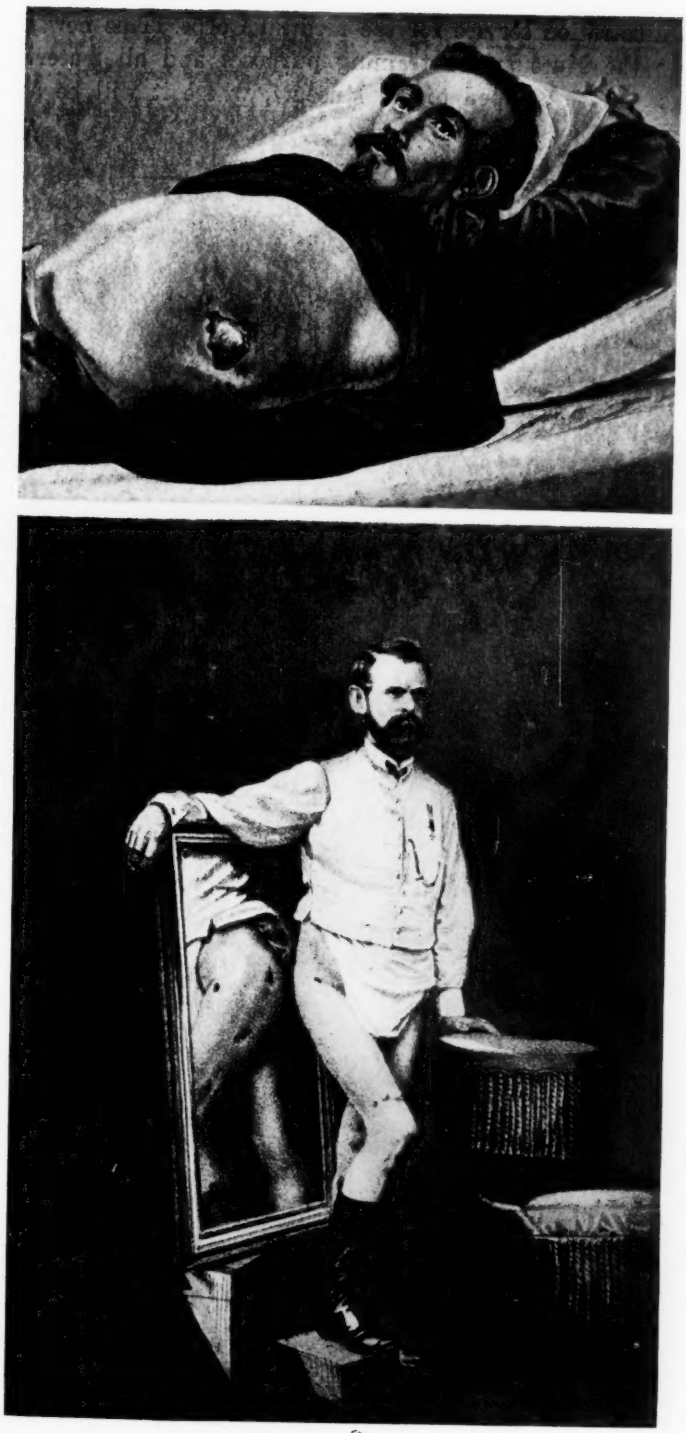

Fig. 3.—*A*, Shot wound of the thorax and abdomen, with hernia of the lung. A reproduction from the original drawing by Edward Stauch. *(Medical and Surgical History of the War of the Rebellion*, Part I, Vol. II.) *B*, Gunshot fracture of the right acetabulum and the head of the femur. Reproduced from a lithograph of an original photograph. *(Medical and Surgical History of the War of the Rebellion.)*

and efficient illustration service for the Medical Corps. This new organization is attached to the Museum for training purposes and all material collected by such units will be shipped to the Museum, where it will be available for study and research.

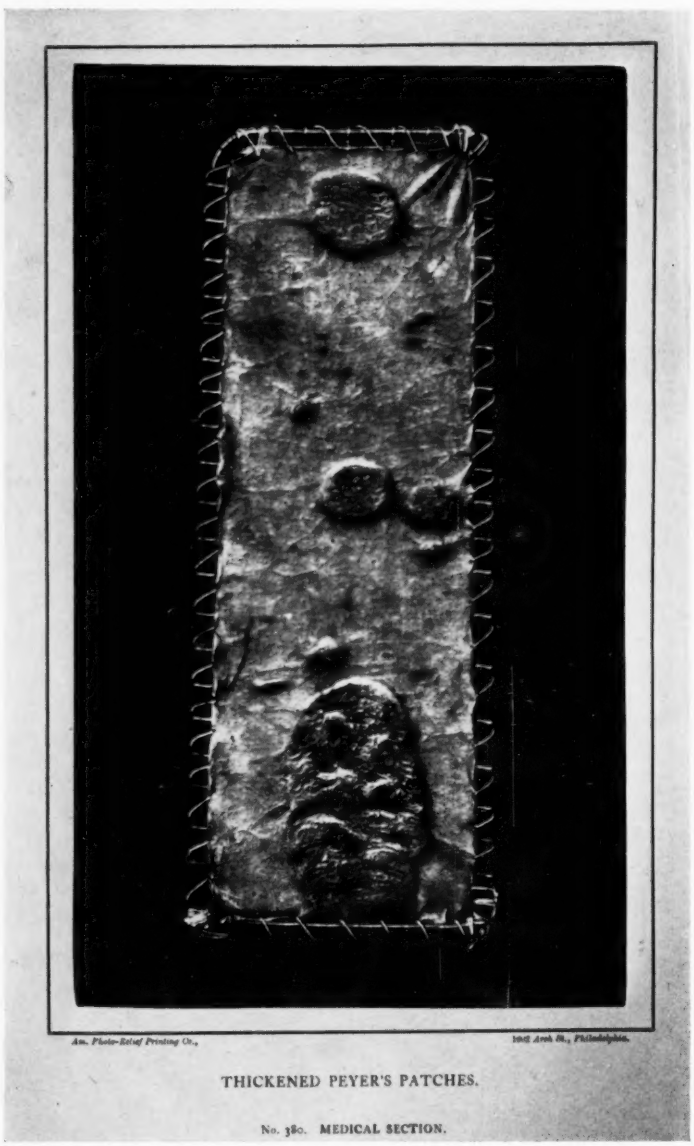

Fig. 4.—Photograph of a gross specimen. *(Medical and Surgical History of the War of the Rebellion.)*

In addition to the illustration activity this organization will also be responsible for the collection of missiles and helmets that have been struck by gun or shell fire, of medical and surgical instruments of American, allied or enemy origin, especially those which have been developed or materially

modified during the progress of the war, and of any other similar apparatus that might prove of historical value. Pathologic specimens are also to be included in the collection.

Units will be attached to the larger medical installations in the various important theaters of operations and will be under the direction of the surgeon of each theater. It is highly probable, therefore, that a unit may be temporarily divided and a photographer or artist ordered to cover an individual assignment.

Provisions have also been made for the employment of a limited number of Civil Service personnel. These men or women will be attached to the larger general hospitals within the continental limits of the United States and will be assigned wherever their services are required.

These units will be equipped with still and motion picture equipment, together with material to produce color as well as black-and-white photographs. Suitable and adequate art supplies will be furnished to the medical artists. All of the photographic supplies and most of the art materials will be furnished by the Signal Corps while in the theater of operations.

Arrangements have been made whereby the Signal Corps facilities will be available for photographic processing. Proper labeling and the identification of all illustration material is of the utmost importance, and each man is specifically instructed in this regard.

The qualifications of the officers in charge of each unit will be of special interest, and the following is a brief, concise outline of the requirements.

1. It is essential that the officers have a rather broad training with experience in the field of medical illustration, particularly photography.

2. They must be experienced in supervising, planning and directing the activities of a medical illustration department.

3. According to The Adjutant General's Office, applicants for a First Lieutenant in the Sanitary Corps must be at least thirty years of age, have a college degree, and, of course, there is always the matter of an Army physical examination.

4. Last, but by no means least, the candidates must be *officer material*. In that phrase is embodied a number of qualities which are quite aside from the professional requirements, but are extremely important to the success of an officer and his entire unit of men.

With regard to the enlisted men, thus far we have been able to select men who have served as assistants in various medical photographic and art departments throughout the country. Most of them were already in the armed service prior to the organization of the Museum and Medical Arts Service, and it was necessary to effect a transfer so that their special training would be available to the Medical Department. In other instances, they have been enlisted for duty at the Army Medical Museum.

In any event, it is essential that each enlisted man receive the required three months' basic military training at an Army camp.

The same requirements hold true for the artists. The majority of the artists now on duty have had formal training in medical art. A great many portrait and landscape artists have applied in writing or in person. One of our

greatest problems is the matter of explaining the fact that medical illustration requires a special type of training decidedly separate and distinct from the usual academic art course.

At present the artists on duty at the Army Medical Museum are undergoing a training program especially designed to help those who require further instruction in surgical drawing and moulage. They are also preparing basic anatomic drawings for the surgical service of the Surgeon General's Office. In addition, these men prepare drawings of unusual gross specimens which are shipped to the Museum from various Army medical centers. Their cooperation is also solicited in the preparation of scientific exhibits.

The photographers receive training and actual experience with the apparatus and materials which will be employed in an overseas assignment. The photography of patients, gross specimens, and surgical operations will account for the greater portion of their work. There will also be a limited amount of photomicrography.

Although the professional relationship between the medical artist and clinical photographer has shown a decided change for the better in recent years, nevertheless there is still much room for improvement. The majority of enlisted personnel attached to the Museum and Medical Arts Service are younger men. It is necessary that they drill together, work together, often live in the same barracks, and enjoy the same recreational facilities. As a result, it is only logical to assume that in the future men in this profession will enjoy a better understanding and appreciation, and a keener respect for each other's specialty.

Inasmuch as both officers and enlisted men will eventually be assigned to military hospitals or field units, a military training program is essential. This program consists of lectures, training films, and drill formation.

The Training Division of the Surgeon General's Office is working on a plan whereby realistic full-size wax models of various war injuries will be used to demonstrate the actual appearance of war wounds to the enlisted men of the Medical Corps. In addition, duplicate casts will be prepared of latex or a suitable substitute. These thin, sleeve-like appliances, molded and colored to simulate actual war injuries, can be affixed to the arm, leg, or other parts of the body. Worn by men on maneuvers they will convey a realistic sight of what may be encountered on the scene of action. Dressings, splints, and tourniquets may be applied and later checked by the Medical Department instructors.

From the foregoing it can be concluded that the Medical Corps is fully aware of the importance of medical illustration, especially in time of war. Careful preparation and planning have been accomplished, and we are now ready with suitable equipment and trained personnel to meet the illustration needs of the Medical Corps. Obviously this entire program places in the hands of the Medical Department the same powerful documentary and educational implement of visual description which is rapidly revolutionizing the entire teaching profession.

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WAR AND DISEASE

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DISEASE profoundly influences the course of men's lives. Man, from the day of his birth to the day of his death, is in constant battle against disease, either warding it off or trying to conquer it. Disease has determined the migration of races, their colonial expansion, their geographical distribution. It has conquered armies, overthrown empires, and changed the course of history.

In times of peace, as well as war, great epidemics have left their mark upon the history of nations. The fall of the Venetian Republic was caused as much by the constant incursion of bubonic plague as by the armed attacks of her warlike neighbors. The Black Death in England produced as great a revolution in the social and economic life of Britain as all the wars that hardy island waged. The terrific toll the plague took among priests and higher ecclesiastics necessitated the filling of these depleted ranks by ill-trained and often ignorant peasants. Many historians have considered that these clerics, possessed of little respect for the prerogatives of the clergy and more concern for the lot of the common people, were among the most powerful influences leading to the English Reformation.

Dramatic as are the changes produced by disease during times of peace, the effects of disease in times of war are even more cataclysmal. Wars spread disease, and disease, in turn, destroys warriors. Epidemics in past wars have only too often destroyed armies and left nothing behind but a melancholy

account of their progress. In some wars, epidemics, although they have destroyed thousands, have left some clue that enables later generations to conquer or to prevent them. In other wars we have the melancholy picture of the deaths to thousands which could have been prevented by the intelligent application of measures already known to medical science. This picture, unfortunately, appears with distressing frequency as we turn the pages of medical history.

The great plague of Athens was one of the most dramatic episodes in the history of civilization. Whether this was a bubonic plague, as Francis Adams of Banchory, who was not only an eminent physician but an outstanding Greek scholar, asserted, or whether it was typhus fever or scarlet fever as others maintain, is beside the point. The Athens of Pericles presented a level of culture and intelligence never before or since equalled. Within the walls of this city of some two hundred thousand, lived and worked the dramatists Aeschylus, Sophocles, Euripides, and Aristophanes; the philosophers Plato, Xenophon, and Anaxagoras; the sculptors Phidias, Praxiteles, and Polygnotus, and the historian Thucydides. When the Spartan king Archidamus attacked Athens, Pericles followed what is called today a "scorched earth" policy. He withdrew all his soldiers and people from the outlying country and they swarmed into the walled city of Athens for protection. The housing conditions were inadequate, and the food supply was insufficient; the proper disposal of refuse became impossible, and the water supply became contaminated. Then, like a thunderbolt, the plague appeared with all its horrors which have been so graphically described by Thucydides, an eye witness of the harrowing scenes.

The Spartan king prudently withdrew and attacked elsewhere. He feared the epidemic might spread into his own army, and he also wisely reckoned that the plague would destroy more Athenians than could the Spartans. According to some authorities, the first wave of the epidemic destroyed one-third of the inhabitants of Athens; according to others, two-thirds. After the first wave had subsided somewhat, Pericles sent an expedition to capture Potidaea and harass the Spartans from the rear. This expedition, if successful, would have changed the entire course of the war. Unfortunately, the men carried the seeds of the pestilence with them and, before the ships reached Potidaea, the disease raged among the soldiers and sailors, and the fleet was compelled to return to Athens. Pericles then planned another brilliant stroke. He sailed with his troops to Epidaurus, hoping to capture that city and again strike the Spartans from the rear. This expedition was also a dismal failure because, according to Plutarch, "the distemper which prevailed in his army broke all his measures, for it not only carried off his own men, but all that had intercourse with them."

Athens slowly went to her doom. When the plague struck down Pericles himself, no leader of equal ability arose to take his place. Finally, the Spartan admiral, Lysander, sailed into the harbor of Piraeus; the Spartans tore down the long walls of Athens to the merry tune of Spartan flutes, and young Spartan women danced gaily to the music while the Athenians filled the air with wails and lamentations. The Athenian Empire was humbled to the dust, never to rise again. The plague of Athens had played a catastrophic part in her defeat, and had left no clue to prevent similar catastrophes.

Unfortunately, the historians of the Peloponnesian War—the war between Athens and Sparta—were not medical men. If Hippocrates, as well as Thucydides, had described the plague of Athens, there would probably be no uncertainty concerning the nature of this epidemic. Fortunately, some of the epidemics accompanying later wars were described by surgeons in varies armies with such accuracy and fidelity that the diagnosis is certain.

Few wars in history have lasted so long or have been more destructive of life and property than the Thirty Years' War. This war, which began as a struggle between Protestants and Catholics, became a war in which the Protestants of Germany and Sweden were allied with Richelieu, the great Catholic prelate, in the struggle against Catholic Austria. This war was a "total war" in the modern sense. Far more civilians—men, women, and children—were destroyed than soldiers. Germany, according to some authorities, lost one-half of her entire population; according to others, two-thirds. A century and a half passed before the population of Germany reached its pre-war level.

The Thirty Years' War is commonly divided by historians into the Bohemian period, the Palatine period, the Danish period, the Swedish period, and the French period. The medical historian, Prinzing, divides it into the typhus period and the plague period.

The disease which carried off so many victims in the early part of this war was the notorious Hungarian disease, a disease accurately described by Tobias Cober, who served as surgeon in the army of Rudolf II, King of Hungary, in the wars against the Turks. He notes that the disease raged especially in camps heavily infested with lice, and his description leaves no doubt that it was typhus fever.

Measures were taken by certain cities to prevent the twin pestilences, typhus and plague, from entering. In Munich, for instance, the city fathers shut the city's gates against all strangers, disinfected all incoming letters, and washed with vinegar all the money that came in. These measures stayed the hand of the plague for a time but presently, infected Spanish soldiers forced their way into the city and spread the disease among the inhabitants. More than one-half the population died from the plague in a few months.

Many great generals, Tilly, Wallenstein, and Gustavus Adolphus, perished in the course of the war. When we balance the results of this war in the terms of great victories, territory gained, and prestige enhanced, as against the losses through pestilence, we may safely conclude that the real victors were typhus and plague.

Napoleon, the greatest military genius of the nineteenth century, was really defeated before Waterloo; he was defeated by his ill-starred campaign in Russia. The Grand Army, to quote Larrey, Napoleon's great surgeon, set out for Russia 400,000 strong. Six months later this army, retreating from Russia, finally reached Gumbinnen in East Prussia, numbering only 3,000.

This disastrous adventure of Napoleon has been described in every history of Europe. The bloody battles, the intense cold, the ferocity of the Russian Cossacks, have all been stressed as the cause of Napoleon's defeat. The role played by disease was even more important. Typhus fever seems to have played the major role, ably assisted by typhoid and dysentery.

The accounts left by the surgeons in Napoleon's army give us a clear picture of the devastation caused by disease. One of the most dramatic was written by Kerkhoffs, a Dutch surgeon attached to the Third Army Corps of Marshall Ney. This Corps, Kerkhoffs relates, was finally reduced to twenty men, as the result of privation and disease. In discussing the failure of the campaign, Kerkoffs remarked that if Napoleon had contented himself with occupying Poland and organizing sanitation there, the campaign would have succeeded and changed the whole course of history.

But Napoleon was in a hurry. In spite of bloody battles and ever-increasing number of sick, he pressed on to Moscow, carrying wagon loads of infected soldiers into that city, leaving the desperately sick in towns and villages where they infected the new troops pressing on eastward.

Sergeant Bourgogne of the Grand Army wrote an interesting account of the march into Russia. He was particularly impressed by the large number of vermin he saw. He went to sleep on a reed mat in a little town of Poland. Presently he awoke from his slumber and finding himself covered with lice, stripped off his shirt and trousers and threw them into the fire. There were so many of these animals on his garments that they "exploded like the fire of two ranks of infantry."

The role of lice in the production of typhus fever was not discovered until a century later. However, Napoleon's surgeons write so much about lice that we wonder if they did not suspect them. They were aware, however, that typhus was highly contagious. One surgeon observed that York's Prussians, who had not been in Moscow at all, had no cases of typhus fever until they followed the retreating French. Another army corps had no typhus until it passed along a road previously used by the French. After a march of fourteen miles on this road, there were fifteen to twenty men in each company ill from this disease.

Napoleon's disaster in Russia was not the first time he had been defeated by disease. His previous campaign in Syria had ended in retreat before an advancing epidemic of bubonic plague. History records that Napoleon mingled freely among the plague-infested soldiers at Jaffa to show his contempt for the disease and that his surgeon, Desgenettes, inoculated himself with pus from the buboe of a sick soldier, to prove that the disease was not contagious. Desgenettes remained perfectly well, probably because, as we now know, the pus from plague boils often contains very few plague bacilli.

The ravages of typhus, typhoid, and dysentery did not cease with the end of Napoleon's Russian campaign. The retreating army scattered pestilence far and wide. Typhus fever broke out in East Prussia and caused the death of 20,000 inhabitants. From East Prussia it spread rapidly to other parts of Germany, to Silesia, Saxony, Bavaria, and the Rhineland. Prinzing estimates that 10 per cent of the population of Germany contracted typhus fever, and 200,000 to 300,000 died. From Germany it spread to France, where it also caused an appalling toll. In Metz all the physicians contracted the disease and many of them died. In the Department of Moselle alone, more than 10,000 died from typhus, this figure not including soldiers.

Typhoid fever, long confused with typhus, has caused a greater number of deaths than typhus in the armies of nations whose hygienic standards do not tolerate the presence of lice.

In the American Civil War, 186,000 troops of the Union Army died of disease as compared with 44,000 killed in battle and 49,000 who died of wounds. Typhoid fever caused the death of 36,000 soldiers.

The health record of the American Army during the Spanish-American War gives us no cause for pride. During this minor struggle sixty-seven officers and 1,872 men died of disease, and twenty-nine officers and 440 privates were killed in action. The death rate in the army camps became so high as to constitute a national scandal. A commission headed by Walter Reed, was appointed to study sanitation in the army camps. They found that "more than ninety per cent of the volunteer regiments developed typhoid fever within eight weeks after they came into camp."

The report of this commission remains a monumental contribution to our knowledge of typhoid fever. They found that the most important carriers of the infection were flies, which feasted on the dejecta of patients and then crawled over the food in the mess halls. Ignorant, untrained hospital orderlies also spread the disease. Without even washing their hands, many of these orderlies left the hospital wards and walked into the mess hall where they prepared food for the soldiers.

The typhoid bacillus was discovered eighteen years before the Spanish-American War, the Widal reaction had been in use for three years, the mode of infection and methods of prevention had long been known. Yet in an army of 107,973 men, there were 20,738 cases of typhoid fever.

The Boer War was an even greater blot on the pages of the history of sanitation. The British had apparently profited little by the American experience. In this war, the British Army lost 22,000 men, of whom 8,000 had been killed in battle or died of wounds, while 14,000 died of preventable diseases. There were 57,684 cases of typhoid fever with 8,022 deaths. The typhoid bacillus had killed more men than the Boers.

The high typhoid fever rate in the British Army during the Boer War, seems inexcusable in the light of present knowledge. Three years before the Boer War, Wright had demonstrated the protective value of antityphoid vaccines, and two years later had inoculated four thousand men of the British Indian Army, with excellent results. The British Army in South Africa authorized—permitted is perhaps a better word—voluntary vaccination. The vaccination was carried out in a rather haphazard fashion, records were poorly kept and often lost. The army authorities finally forbade the inoculations altogether.

Two years after the close of the Boer War a Royal Commission appointed to study the value of antityphoid vaccination issued a favorable report which rehabilitated the procedure of antityphoid inoculation. It came too late to aid the typhoid victims of the Boer War, but it carried a poignant message to the armies in future wars.

With the turn of the century there came a turn in the health record of armies engaged in war. During their war with China in 1894 and 1895, the Japanese lost four times as many soldiers from disease as from bullets. Indeed, this had been the record of armies for decades. These figures appalled the Japanese government, which reorganized its military medical service and

sent thousands of young Japanese all over the world to study the latest advances in sanitation. Japan, to quote Major Seaman, writing in 1905, "even had the temerity (strange as it may seem to an English or American Army official) to grade her medical men as high as officers of the line, who combat the enemy that kills only 20 per cent."

The report of the Japanese Army at the end of the Russo-Japanese War showed the wisdom of their policy. Seven per cent died in battle; 1.5 per cent died of disease.

The first World War proved that the United States Army had profited by its own mistakes in the Spanish-American War and by the mistakes of the British in the Boer War. The lessons of the Russo-Japanese War had also been studied and learned.

Typhoid fever, the great scourge of past wars, claimed only 213 victims in the American Army of 4,000,000. If the typhoid death rate of the Spanish-American War had prevailed, more than 68,000 soldiers would have lost their lives from this disease. Surgeon General Ireland of the United States rightly attributed this decline to vaccination and improved sanitation, including careful examination of cooks and food handlers.

Tetanus caused only four deaths in the American Army, less than two out of every hundred thousand wounded. This figure is especially noteworthy, since the British in the early years of the war had 32 cases in every thousand wounded. Prophylactic injections of tetanus antitoxin in all the wounded explained the astonishing American figures.

Typhus fever did not cause a single death in the American Army. The figures from Russia were quite different and, indeed, appalling. During the war and the succeeding revolution, sanitation broke down completely in Russia. There were more than twenty million cases of typhus in Russia, with three million deaths.

The medical experiences of the World War demonstrated the great advances made in the prevention, control, and cure of certain infectious diseases. Two great groups of diseases remained, however, untamed. "The sputum-borne infections," observed Colonel Garrison, "particularly the pneumonias, remained the insoluble problem of the war." To this must be added streptococcic infections, which caused 70 per cent of the fatal infections in the British Army. The discovery of the therapeutic effect of the sulfonamides in 1933 bids fair to mark the beginning of the solution of what Garrison called the insoluble problem of the World War.

While we think of disease and war, we are prone to think only of infectious diseases and gloss over or neglect the role that disease due to faulty or insufficient nutrition plays. Prominent among these diseases is scurvy.

Scurvy appeared in the armies of the First Crusade. Jacques de Vitry, one of the crusaders, wrote an excellent account of this disease as it appeared at the siege of Damietta in 1219, and notes that it was a "pestilence, against which the doctors could not find any remedy in their art." Later in the Seventh Crusade of 1248, the army of Louis IX of France was attacked by this disease, and no one, reading the account of Sieur de Joinville, can doubt that scurvy was largely responsible for the disaster that befell Louis' army.

In 1535 Jacques Cartier's expedition to Canada suffered greatly from scurvy and probably would have perished to the man, except for the aid of the Indians, who told him that a decoction of the bark and leaves of the fir tree would cure the disease. Cartier's physicians had been powerless in the extremity, so we can understand his oft-quoted remark that the decoction of fir "wrought so well, that if all the physicians of Montpellier and Louvain had been there with all the drugs of Alexandria, they would not have done so much in one year as that tree did in six days."

The work of James Lind, who found that lime juice added to sailors' rations would prevent scurvy, is one of the great discoveries in medicine. Yet, incredible as it seems today, Lind waited forty-two years before he saw his measure put into effect by the British admiralty. The French seemed even more blind than the British to the importance of Lind's discovery. Larrey relates that Napoleon's army in Egypt was decimated by scurvy in 1799, incidentally forty-six years after Lind's discovery. The addition of lime juice to the rations of the French soldiers in Egypt might have proved a decisive factor in the campaign.

Since the demonstration that citrus fruits, added to rations, prevents scurvy, this disease has lost its military importance. In the recent Italo-Ethiopian War, there was not a single case of scurvy in the Italian Army, although the Ethiopian Red Cross reported over thirty thousand cases of scurvy on the Somaliland front alone.

The medical history of the present war remains to be written. Much can happen in the domain of diseases as well as in the field of strategy. Thus far, the glimpses we have had are encouraging.

The plaster of Paris method of treating wounds, as advocated by Orr and given a wide application in the Spanish Civil War, has had a marked effect in lowering the death rate from compound fractures. The sulfonamide drugs have been employed with gratifying effects in streptococcus infections, in pneumonia, and in meningitis. Sulfathiazole has proved a great value in curing as well as in preventing gonorrhea, a disease which in the last war kept several divisions constantly hospitalized.

Typhus fever in the present war has not been a serious menace. An epidemic of typhus has not appeared in Serbia as in the last war, probably because sanitation has improved there and the Germans are remembering the lessons of the previous epidemics. The same also holds for the occupied portions of Russia. The great epidemic in Russia during the last war appeared principally during the chaos of revolution.

While it is apparent today that methods of destroying life are more effective than ever before in history, it is comforting to the physician to know that methods of saving life are more numerous and more effective.

SIMPSON MEMORIAL INSTITUTE
ANN ARBOR, MICH.

BOOK NOTICES

Books Dealing With War Medicine

War Medicine*

A Symposium

IT IS appropriate in the present emergency to republish collected papers on a subject of such tremendous immediate importance as war medicine, papers which have been scattered in a dozen or more journals, some in this country, some in Canada, and many in England. Most of the authors who have written on subjects dealing with war medicine are now actively engaged in the war. It would be folly to ask them to contribute rehashes of what they have already written, merely for the sake of calling it a new and original contribution. Such a procedure would not contribute to the prosecution of the war. The republication of outstanding contributions has been adopted with some of the articles appearing in the two War Medicine Numbers of THE JOURNAL OF LABORATORY AND CLINICAL MEDICINE in order to supplement and round out the symposium of original contributions.

The volume under review, "War Medicine, A Symposium," edited by Commander Pugh and Doctors Podolsky and Runes, is especially effective in presenting the most recent advances in war surgery. This fills approximately two-thirds of the volume. There are two other sections, "Aviation and Naval Medicine" and "General Medicine." The collected writings round out the entire field, but the volume is recommended especially for those dealing with war surgery.

A Short History of Nautical Medicine†

READERS of Captain Roddis' *A Short History of Nautical Medicine* will not be limited to naval physicians. This thoroughly interesting volume will appeal to army physicians as well as to naval medical men, to nonmedical naval men and seafarers in general, to historians and to nutritionists. Starting with the sparse records of maritime medical service used by the ancients, it traces the contributions in this field down to modern times. Captain Roddis lists some of the most important as (1) the conquest of scurvy (a fascinating story); (2) the distillation of drinking water; (3) the introduction of smallpox vaccination among sailors; (4) improved personal hygiene; (5) the institution of quarantine (and we learn here that the word is derived from the forty days of detention); (6) improvements in ventilation on shipboard; (7) the institution of preliminary physical examinations; (8) improvements in medical service on shipboard; (9) the development of naval hospitals and hospital ships, etc. The author develops the history of nautical medicine during the last few hundred years, especially through the story of the British Navy and the United States Navy. The book abounds in interesting anecdotes, especially in these two groups.

*War Medicine. A Symposium. Editor Winfield Scott Pugh, M.D., Commander, M. C., U. S. Navy, Retired; formerly surgeon, City Hospital, New York; Associate Editor Edward Podolsky, M.D.; Technical Editor Dagobert D. Runes, Ph.D. Cloth, 565 pages, $7.50. F. Hubner & Company, Inc., New York, 1942.

†A Short History of Nautical Medicine. By Louis H. Roddis, M.D., Captain, Medical Corps, United States Navy. Cloth, 12 illustrations. 359 pages, $3.00. Paul B. Hoeber, Inc. Medical Book Department of Harper and Brothers, New York and London, 1941.

Medical Manual of Chemical Warfare*

THE *Medical Manual of Chemical Warfare* is a reprinting of an official British manual. It contains a general description of war gases and detailed discussion of the different types, such as blister gases, choking gases, paralyzing gases and harassing gases. The list is quite complete. The volume describes methods of protection, recognition, and first-aid treatment. With deep regret we are forced to say that this volume will probably be very useful in the next years. The approach is clinical and practical.

What the Citizen Should Know About Wartime Medicine†

THE most recent of a series of twelve volumes to date of *The Citizen Series* is *What the Citizen Should Know About Wartime Medicine*. The books include subjects, such as what the citizen should know about the Army, the Navy, the Coast Guard, the Marines, Air Forces, Civilian Defense, submarine warfare, etc. Colonel Darnall and his associate author, V. I. Cooper, have given us an adequate presentation of the many functions of the medical services in the armed forces. This includes the organization of the medical department, aviation medicine, military psychiatry, sanitation, hygiene, the prevention and control of infectious diseases, the venereal disease problem, and war surgery. So much must be said in these fields that there is no space for history of the development of medical problems in past wars.

The book is written primarily for the layman. The diversified activities of the medical departments sometimes make it difficult for an officer in the medical service assigned to a highly specialized task to realize how many other problems are being prosecuted in his own department of the Army or Navy. For this reason, the volume will make interesting reading for men in the medical services.

Dermatologic Therapy in General Practice‡
Manual of Dermatology

TWO books on dermatology, written in part for the services, should be reviewed together, not so much because Dr. Sulzberger is coauthor of both books but because in actual practice the volumes will be found to be supplementary to each other.

The *Manual of Dermatology* has been issued under the auspices of the Committee on Medicine of the Division of Medical Scienes of the National Research Council and written by Donald M. Pillsbury, Marion B. Sulzberger, and Clarence S. Livingood. Prefatory notes by the Surgeon Generals of the Army and Navy explain the need for such a volume for use in the armed services. Nearly 10 per cent of all admissions to sick list and 10 per cent of all days lost on account of sickness are due to dermatologic maladies. This volume is in essence a vade mecum for physicians who are called upon to treat skin diseases. Most of the information and directions are tabulated and are very brief. The illustrations are so numerous and so excellent as to make it almost a dermatologic atlas. Important directions and cautionary remarks are emphasized by being boxed in.

The other volume *Dermatologic Therapy in General Practice* by Lieutenant Commander Marion B. Sulzberger and Dr. Jack Wolf is somewhat larger but is still of conveniently small size and presents adequately minute details of the methods of applying treatment

*Medical Manual of Chemical Warfare. Reprinted by permission of the Controller of His Britannic Majesty's Stationery Office, revised edition, 1942. Cloth, 121 pages, $2.50. Chemical Publishing Company, Inc., Brooklyn, N. Y.

†What the Citizen Should Know About Wartime Medicine. By Joseph R. Darnall, M.D., Lieut. Col., M. C., U. S. Army; and V. I. Cooper. Illustrations by André Fandot. Cloth, 237 pages, $2.50. W. W. Norton & Company, Inc., New York, 1942.

‡Dermatologic Therapy in General Practice. By Marion B. Sulzberger, M.D., Lieut. Comdr., M. C., U. S. N. R., Assistant Clinical Professor of Dermatology and Syphilology, Skin and Cancer Unit of the New York Post-Graduate Medical School and Hospital of Columbia University; Associate Attending Dermatologist, Montefiore Hospital, New York City; and Jack Wolf, M.D., Attending Dermatologist and Syphilologist, Skin and Cancer Unit of the New York Post-Graduate Medical School and Hospital of Columbia University; Director of Dermatology, New York City Cancer Institute. Cloth, 632 pages, The Year Book Publishers, Inc., Chicago, 1942.

Manual of Dermatology. Issued under the Auspices of the Committee on Medicine of the Division of Medical Sciences of the National Research Council. By Donald M. Pillsbury, M.D., Marion B. Sulzberger, M.D., Clarence S. Livingood, M.D. Cloth, 421 pages, $2.00. W. B. Saunders Company, Philadelphia & London, 1942.

which are briefly touched upon in the *Manual of Dermatology*. The approach to dermatologic therapy in this book is definitely different from that of most textbooks on skin diseases. While the importance of accurate diagnosis is recognized and diagnostic discussion appears in the second portion of the book, emphasis in the first part is placed upon selection of the appropriate treatment based upon the character of the skin manifestation rather than upon its nosologic classification. In other words, one can apply the appropriate type of treatment in the great majority of cases even though one may not have had sufficient dermatologic experience to make the correct diagnosis in some unusual dermatosis.

These two volumes will be of greatest value when used together.

Fundamentals of Psychiatry*

WHEN millions of men are drafted into the armed forces, large numbers of neurotics, psychoneurotics, and psychotics are bound to be overlooked in the preliminary draft appraisal and admitted into the Army, Navy, or Marines. The tremendous stress of service life even without the emotional problems of combat activity serves to bring out psychotic tendencies in many who might have gone years longer before becoming ill. Military psychiatry is a vast field in its own right. Dr. Strecker's small volume, *Fundamentals of Psychiatry*, is, as its name implies, a synopsis of the subject of psychiatry and methods of psychiatric examination and treatment, in which he has incorporated much discussion of psychiatric problems of wartime.

War Gases†
Their Identification and Decontamination

THE British book, *Medical Manual of Chemical Warfare*, reviewed elsewhere, presents a comprehensive discussion of the uses and damaging effect of war gases. The present volume by Morris B. Jacobs, formerly Lieutenant in the U. S. Chemical Warfare Service Reserves and Chemist in the Department of Health of The City of New York, presents a similar discussion which the reviewer feels is better classified. The volume deals first with the classification of the chemical agents, then with the physical characteristics and physiological responses to war gases, and next with the effect of war gases on inanimate material, such as food and water. There is a section on sampling of gases and methods for analytic determination of their nature. The final section deals with methods of decontamination. Before the war is over, this volume will probably be widely used as a quick reference manual.

Civilian Health in Wartime‡

DR. DIEUAIDE'S volume, *Civilian Health in Wartime*, is in great measure a treatise on preventive medicine applied to the individual and to groups, which would be equally readable in peacetime. Written primarily for the layman, it provides at the same time an excellent refresher or orientation manual for the physician, nutritionist, and public health worker. The author discusses the effect of war on civilian health. He gives considerable attention to nutrition and diet. He next discusses infectious diseases and methods of control.

The importance of proper clothing and housing conditions is discussed. Maternal and child welfare, as well as geriatric problems, are presented in an easily readable style which should be of real interest to the intelligent layman. Other subjects include recreation, occupation, morale, and a chapter about doctors and nurses, how they work and what they can be expected to accomplish.

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*Fundamentals of Psychiatry. By Edward A. Strecker, M.D., Sc.D., F.A.C.P., Professor of Psychiatry and Chairman of the Department, Undergraduate School of Medicine, University of Pennsylvania; Psychiatrist to the Pennsylvania Hospital; Attending Psychiatrist, Psychopathic Division, Philadelphia General Hospital. Cloth, 15 illustrations, 201 pages, $3.00. J. B. Lippincott Company, Philadelphia, London, Montreal, 1942.

†War Gases. Their Identification and Decontamination. By Morris B. Jacobs, Ph.D., Food, Drug and Insecticide Administration, U. S. Department of Agriculture, 1927, Chemist, Department of Health, City of New York, 1928; formerly Lieut. U. S. Chemical Warfare Service Reserve. Cloth, 180 pages, $3.00. Interscience Publishers, Inc., New York, June 26, 1942.

‡Civilian Health in Wartime. By Francis R. Dieuaide, M.D., Associate Professor of Medicine, Harvard Medical School, Massachusetts General Hospital. Cloth, 328 pages, $2.50. Harvard University Press, Cambridge, Mass., 1942.